

THE
THREE
HEAVENS

REV. J. CRAMPTON, M.A.



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Rev. W. H. S. Hartley
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THE TWO OCEANS.

(1) Aerial Ocean; (2) Greatest height attained by Messrs. Glaisher and Coxwell, being 36,960 feet, or seven miles above the sea level. (3) Aerial Alps, or stratum of clouds, 15,000 feet in depth. (4) Highest bird-region.

THE THREE HEAVENS.

BY THE

REV. JOSIAH CRAMPTON, M.A., M.R.V.I.,

Rector of Great Sutton, Essex

AUTHOR OF "THE LUNAR WORLD."

Third Edition.

"In ardent contemplation's rapid car,
From earth, as from my barrier, I set out.
How swift I mount : diminish'd earth recedes !
I pass the moon, and, from her farther side,
Pierce heaven's blue curtain ; strike into remote
Where, with his lifted tube, the subtle sage
His artificial airy journey takes,
And to celestial lengthens human sight.
I pause at every planet on my road,
And ask for Him who gives their orbs to roll,
Their foreheads fair to shine."—YOUNG.

LONDON :
WILLIAM HUNT AND COMPANY,

12, PATERNOSTER ROW.

1852.

Preface to Third Edition.

WHILE the publisher is issuing a new edition of the "THREE HEAVENS," two comets are decorating the *second heaven*; while a wave of heat, such as has not been experienced for forty years, has passed over the usually temperate climate of Great Britain, scorching our mother earth, oppressing and killing in America several hundreds of her inhabitants. The coincidence of the heat with the appearance of the comets leads naturally to the repetition of the vulgar error (long since abandoned by scientific men), that comets and extraordinary heat on the earth are simply cause and effect. Scientific inquiry and examination, however, have long since dissipated such a conclusion, for which there is not the slightest foundation, the appearance of a comet having never raised the terrestrial temperature a fraction of a second. That hot weather has occasionally visited the earth while a comet was visible is true (but is a mere coincidence). Such was the case when the famous comet of 1811 appeared, which was said to have produced by its heat

the finest flavoured wine that ever was known, in those days called comet wine. But the question may be fairly put to those who still believe in cometary heat on the earth. How many hot summers have we experienced when there was *no comet*, and how many cold summers were experienced when a comet was present? The result of such an examination would at once prove that the presence of a comet and great heat have no relation to each other; but a telescopic and spectroscopic examination of a comet itself at once dissipates such a notion. A faint cloudy object through which the stars can be seen, as even in Donati's splendid comet, and, notwithstanding their alarming appearance occasionally (as that comet's was), not producing more effect than the lightest cloud or mist would do upon the earth, and, so far as its gravity is concerned; while the comet itself is attracted by every planet or star which it approaches, it attracts nothing of itself. The comet which is now visible is certainly not an alarming one, and though its head, which is pretty well defined, is probably as large in diameter as the planet Jupiter, yet, in its blue and lambent flame and misty tail, there is nothing to convey the idea of heat or solidity, but rather possibly of cold and vapour; for a great portion of its light proceeds (as Mr. Huggins informs us, by the application of the spectroscope) from reflection, as the moon's. So that the probability is, did a collision take place with the earth, it would be shortly dispersed like a morning mist.

The extremes of heat and cold, however, which we have

recently experienced within the space of the last few months in this country, are a much more serious and dangerous matter than the possible collision of any comet with the earth. A continued temperature through three months of last winter of more than twenty degrees of frost, not to speak of snow in many places of from fifteen to twenty feet in depth, accompanied by an icy tempest, blocking up every road and railway in the three kingdoms,—this was a far more dangerous visitation than that of any comet; and now we have had the opposite extreme with the thermometer at ninety-eight in the shade, and a tropical heat directly from the sun, causing, in America as well as over Europe, hundreds of deaths. These phenomena are far more alarming and disastrous. The cause of this sudden eruption of cold and heat this year cannot be explained on scientific principles. Some scientific men (it is true) have said that the falling of meteoric bodies into the sun would be sufficient to cause him to blaze with additional heat, as oil or combustibles would when cast into the fire. Such speculations, however, have never been proved; but there is no doubt that there are periods when the sun, from some unknown cause, being violently agitated, casts forth molten matter to an enormous distance: on one occasion to a distance of 350,000 miles. Such a disturbance of his fiery surface would probably cause an immense accession of solar heat, which (that it would be felt on the earth) is proved by the fact that the opening of a single solar spot (as seen by Mr. Carrington) produced an instantaneous magnetic storm in our telegraph wires here.

None of these facts, however, will account for the sudden increase of heat on our globe this summer; and giving up all scientific explanations of such phenomena on this occasion, we are compelled to refer such changes to the Almighty Maker of the sun, as well as the earth,—who, not by miracle, but by the ordinary means of His providence (hidden from us), chooses and determines to visit our globe with such climates (generally or specially) as He thinks fit. In accordance with such view, it is that not only does our Church provide in our Prayer-book special prayers and thanksgivings for the seasons, but on special occasions special prayers are *composed* in relation to such phenomena, and not only by our Church, but by other denominations. With reference to the increase of heat, or cold, it would be quite possible to convert our present agreeable and moderate temperature into an Arctic or a tropical and unbearable one,—changes which have taken place before in our terrestrial climates, as geologists will tell us. There is a remarkable passage to that effect in Rev. xvi. 8, where, in the pouring out of the seven vials, it is said in the 8th verse: “And the angel poured out his vial upon the sun; and power was given him to scorch men with fire. And *men were scorched with great heat*, and blasphemed the name of God, *who hath power over these plagues.*” Now, although this is doubtless figurative, yet the idea and possibility of such a phenomenon occurring is, at all events, put forward by St. John, who was no astronomer nor scientific man, but who here claims the fact that *God has the power* to visit the earth in this manner. So,


in like manner, with regard to the extremes of cold we experienced recently, He who said, “*Cold* as well as *heat* should endure so long as the earth remains,” doubtless sometimes uses both these ordinances occasionally, and with special power, for His purposes. Thus—“He casteth out *His* ice like morsels,”—“He saith unto the snow, Be thou upon the earth,” saith Job,—“Who can stand before His cold?” says David. (Ps. cxlvii. 17.) In truth, the wonderful phenomena pertaining to this globe are in the hands of Him who directs and orders them according to His own wisdom and will and Almighty power; and no scientific theory or explanation will ever satisfy and explain the exceptional cases, when heat and cold, snow and sun alternately work out for our Creator His great and doubtless special purposes, before which all Nature must bow.

The Author commits this third edition of the “Three Heavens,” as he has the former editions, to Him who is the Almighty Maker of all things, who ordains every movement or change among them, without whose will not a sun would give a ray of light or heat through the universe, nor a star shine through the darkness, nor a moon walk the heavens in beauty, nor a breath of summer warm and cheer us, or a cool breeze refresh us.

J. CRAMPTON.

*Nettlebed Vicarage,
Oxon.,
July 27th, 1881.*

Preface to Second Edition.

 NEW EDITION being required, the author gladly avails himself of the opportunity afforded him of expressing his thanks for the kind and favourable reception of the work by the public and by the members of the press, both in England and in Ireland, who have reviewed it. An attempt to reconcile the facts of physical science with the teachings of Scripture enters debatable ground in the present day, and is necessarily exposed in consequence to hostile criticism, more or less. The author, however, is thankful to say that the result has not been such, and that the reviews in general have been unanimous in the opposite direction.

Since the first issue of the work, two most important and interesting facts have been brought to light: first, the approximate determination of the sun's distance from the earth, deduced from the observations of the transit of Venus, and by which it appears the globe we inhabit is more than three millions of miles nearer the great centre than has been hitherto supposed, a fact which, however seemingly unimportant to us,

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has been justly considered by the Astronomer Royal to be the solving of one of the noblest problems in astronomy. Secondly, the discovery of the two tiny satellites of Mars, by Professor Hall, of America, with the splendid Clark Refractor. This is, if possible, to the students of popular science, a more interesting, if not a more important discovery, it being a great optical as well as scientific triumph; and it may be added, viewing it from a theological standpoint,—a theological triumph. In reference to the scientific view of the matter, the probability of Mars having one or more satellites had been predicted for many years by several able astronomers,* on the grounds of analogy with the other planets; but the difficulty of obtaining sufficient optical power to discover such minute objects, as it was presumed they must be, together with the necessity of searching for them,—when only they could be looked for—within a limited period at the time of the planet's opposition, and at the exact moment when he should be most favourably situated for observation,—prevented the discovery of his moons for the last half century or more; and the failure of so many eminent astronomers to discover them discouraged the most practised observers from directing their attention perseveringly to the subject. Professor Hall, U. S., who was so kind as to present the author with a copy of his work on the discovery and orbits of the satellites of Mars by himself, says, "An examination of the literature of the planet showed such a mass

* As Dr. Lardner, Dr. Dick, and others.—Vide "Three Heavens," p. 215.

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of observations of various kinds, made by the most experienced and skilful astronomers, that the chance of finding a satellite appeared very slight, so that I might have abandoned the search had it not been for the encouragement of my wife. A more complete examination of the observations, however, gave some encouragement, as it showed that hardly any astronomer, since the time of Sir William Herschell, had made a special search for satellites to Mars. *His* failure seems to have convinced astronomers that none existed, and the statement that Mars has no moon became current in our text-books. Professor Hall's perseverance, however, was rewarded by the discovery, on the 11th of August, 1877, of the outer planet; and on the 16th and 17th, of the inner one. The difficulty of their discovery may be imagined, from their very minute size and proximity to the planet. Their diameters being calculated, as respectively, *Phobos* (the inner moon), six miles in diameter, and *Deimos* (the outer one), seven miles; * while their distances from the centre of the planet are, *Deimos*, 14,500, and *Phobos* but 5,800: the latter, consequently, ever within the glare proceeding from its primary, rendered its discovery most difficult."

There are many interesting circumstances connected with these minute bodies. Attendants, named appropriately, *Deimos* and *Phobos* (flight and fear), after the horses that drew the chariot of the warrior god, and intended by Homer, who personifies them, to represent his two attendants.

* Mr. Wentworth Erke (Ireland) makes the diameter of *Deimos* 14 miles.

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"With that he gives command to *fear* and *flight*
To join his rapid courses for the fight.
Then grim in arms with hasty vengeance flies;
Arms that reflect a radiance through the skies."

POPE.—Iliad, book xv., line 134.

One peculiarity belonging to the outer moon is, that its revolution round its primary is performed in less than one-third the time of the primary's rotation on its axis. The effect of this to an inhabitant of Mars would be, that this moon would rise in the west and set in the east. Various other curious and beautiful effects would probably result from the relative position of the two moons, and their very short distance from the planet; but the precise effects produced by their united or successive light, which is pale and silvery, upon this comparatively dull red world, have yet to be fully ascertained, as well as their probable effect upon the tides of his oceans. The distance of the nearest one, Phobos (5,800 miles), from its primary is so slight, that if the Martial inhabitants were possessed of telescopes, or had more powerful sight than we have, every object on this little globe could be discerned with ease. This minute world is probably not inhabited itself; but if it were, the inhabitants would have little trouble in journeying round it, with the fleetness and activity that its slight mass must give, which would enable them to compass it in about an hour.

But leaving these considerations for future speculation and discovery, the theological question already referred to presents itself, as most interesting and important: viz., that the discovery of these two planetary moons exactly fills the gap that was

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wanted to complete the analogical argument for design, from the apportioning of light and gravitating power for illuminating and governing the tides and oceans of planetary worlds. Kepler had remarked upon the exceptional case of Mars being without any moon; and in a letter to one of his friends, shortly after the discovery of the satellites of Jupiter by Galileo, in 1610, says, "I am so far from disbelieving in the existence of the four circumjovial planets, that I long for a telescope to anticipate you, if possible, in discovering *two* round Mars,—*as the proportion seems to require*,—*six or eight* round Saturn, and perhaps *one each* round Mercury and Venus.

Now, how stands the truth? Thus anticipated by the greatest of mathematicians and astronomers of his day, whose celebrated law still remains as the guide to astronomers at the present day, as the compass does to mariners, and will remain so for ever. As to a satellite to Venus or Mercury, nothing can be said *yet*: they exist amidst a glare of light *which* probably enable them to dispense with any satellites, and prevents the possibility of discovering them. But we can pronounce nothing respecting them *positively*, although some eminent Italian and English astronomers have said they had once or twice seen a satellite to Venus. But, waiving this, let us begin with the earth, and how is it now? Earth, 1; Mars, hitherto none, but now 2; Jupiter, 4; Saturn, 8; Uranus, 6 at least, and supposed to have more. But without speculating upon these *remote* and Arctic planets, in the four *within our reach* we have the following figures: 1, 2, 4, 8. Now, can any

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one look at those four figures, and not believe in a designed apportioning of satellite influence, not merely as Kepler saw from an analogical and scientific point of view, but from a theological aspect as proof of intelligent design by an Allwise and Almighty Creator? The result to any thoughtful mind must be here in favour of an *Intelligent* First Cause; and, in the teeth, of all Atheistic or mere material reasonings. The supposed absence of a moon from Mars furnished La Place, the great Astronomer and mathematician, but a materialist, with an argument *against* an intentional arrangement such as is seen now in the analogy of satellites in proportionate compensation to their primary—it seemed a break in the analogy; but *now* the exception is removed, and the proportion, so far as it has been discovered, is perfectly *preserved*. Here are, at all events, four worlds supplied with light and other advantages, in proportion to their size and distance from the sun, and intelligent design is as plain as would be the lighting of different houses or apartments in a palace, by the Master who provided for them in proportion to their size and locality. This admits of no reply: the moons did not arrange themselves round their primary in the order in which they are found, any more than they created themselves. There is not one too many or too few for each planet, but the number and distance and magnitude is exactly suited for the purpose. Many, it is true, had predicted a satellite or two for Mars,* but

* Vide "Three Heavens," p. 215.

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Professor Hall's discovery has rendered further predictions unnecessary.*

The following account of this discovery of the Martial satellites by Professor Hall may interest my readers:—

"My search for a satellite was begun early in August, as soon as the geocentric motion of the planet made the detection of the planet easy. At first my attention was directed to faint objects at some distance from the planet; but all of them

* Among the most curious anticipations of there being two moons to Mars, and a remarkable illustration of the adage, that "Coming events cast their shadows before," are those of Dean Swift and Voltaire, neither of them astronomers themselves, but, on the contrary, holding all mathematicians and philosophers in the utmost contempt; yet both alike, while intending to throw ridicule upon the predictions and assertions of astronomers, unwittingly, by a strange coincidence, predicted the truth. The statement of Swift is to be found in his celebrated Satire of the travels of Lemuel Gulliver to the aerial island of Laputa. After describing his arrival there, and giving an amusing account of the inhabitants,—in which he expends his witty sarcasms upon the philosophers and astronomers there, representing those of his own day, and the various theories propounded by them to alarm the credulous by promised coming celestial catastrophes, which indeed is no exaggerated picture of the teaching of many savans of the present day as well as his,—he thus refers to the satellite of Mars.

Speaking of the Laputian astronomers, he says, "They spend the greater part of their lives in observing the celestial bodies, which they do by the assistance of glasses, far excelling ours in goodness." This advantage has enabled them to extend their discovery much farther than our astronomers in Europe. Among these they have discovered *two lesser stars or satellites*, which revolve round Mars, whereof the innermost is distant from the centre of the primary planet exactly three of his diameters, and the outermost, *five*. "The former revolves in the space of ten hours, the latter in twenty-one and a half. So that the square of their periodical times is very nearly in the same proportion with the cube of their distance from the centre of Mars, which evidently shows them to be governed by the same law of gravitation that influences other bodies." It has been said that these calculations, going so near the truth in these particulars, did not emanate altogether from the mind of the witty and learned Dean, but that he received assistance from some one more conversant with such matters,—probably some astronomer of his day. This, however, it is fair to say, has been denied by some of his biographers, who have asserted that Swift's dislike to mathematics was not due to want of ability for the study, but that the scientific accuracy of his calculation in this, as in the other matters contained in the voyage to Laputa, was from himself alone.

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proving to be fixed stars. On August 10th I began to examine the region close to the planet, and within the glare of light that surrounded it. This was done by sliding the eye-piece so as to keep the planet just outside the field of view, and then turning the eye-piece in order to pass completely round the planet. On this night I found nothing, the image of the planet was very blazing and unsteady, and the satellites, being at that time near the planet, I did not see them. The sweep round the planet was repeated several times on the night of the 11th, and at half-past two o'clock I found a faint object on the following side, and a little north of the planet, which afterwards proved to be the outer satellite. I had hardly time to secure an observation of its position, when fog from the Potomac rivers stopped the work: cloudy weather intervened for several days. On the night of August 15th, the sky cleared up at 11 o'clock, and the search was resumed; but the atmosphere was in a very

Voltaire in like manner exercised his sarcasm on the savans whom Frederick the Great had collected around him. In reference to the Martial satellites, in a work of his, entitled, "*Micromegas Histoire Philosophique*," he describes one Micromegas as an inhabitant of the star Sirius, who, having written a book, which a *suspicious old man* thought smelt of heresy, left Sirius and visited our system—(Voltaire says)—"Our traveller, having traversed the space of about one hundred millions of leagues, drew near at length to Mars, which planet, as is well known, is five times smaller than our little globe, there he beheld two moons, which served the planet, and which had escaped the researches of our astronomers. I know well (he says) that Father Castel (meaning a learned priest of his day) cried out and even wept against the existence of these two moons, but I enroll myself among those who reason from analogy, and these good philosophers know how difficult it would be to believe that Mars, who is so far from the Sun, should be possessed of less than two moons." The pointed acrimony of this, whether directed against science or religion, could hardly be excelled; but, like Swift, he is found unwittingly among the true prophets.

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bad condition, and nothing was seen of the object, which we now know was at that time so near the planet as to be invisible. On August 16th the object was found again, on the following side of the planet, and the observations of that night showed that it was moving with the planet, and, if a satellite, was near one of its elongations. On August 17th, while waiting and watching for the outer satellite, I discovered the inner one. The observation of the 17th and 18th put beyond doubt the character of these objects, and the discovery was publicly announced by Admiral Rogers. Still for several days the inner moon was a puzzle, it would appear on different sides of the planet in the same night, and at first I thought there were two or three inner moons, since it seemed to me at that time very improbable that a satellite should revolve round its primary in less time than that in which the primary rotates. To decide this point, I watched this moon throughout the nights of August 20th and 21st, and saw, in fact, that there was but one inner moon, which made its revolution round the primary in less than one third the time of the primary's rotation,—a case unique in our solar system."

JOSIAH CRAMPTON.

Preface.

ALIFE passed in the country, as the author's has for the most part been, naturally leads to the study and investigation of the wonderful agencies around and above us. There can be no more ennobling employment, no greater refreshment and relief to the burdened spirit of man, than to retire for a while from the world of mankind, and the study of human nature, into any one of the great departments or laboratories of nature herself, and contemplate and study her. The study of the world,—*i.e.*, mankind and their doings,—as narrated in history, or by our own observation, however needful and important and interesting, must always be more or less painful; the crimes or infirmities or sorrows of our race meet us at every point, and are but scantily and poorly balanced by their virtues or excellencies, while they actually contribute largely to our every-day share of care and suffering and anxiety. Not so in the wide

realm of nature, the handiwork of God: nothing can hurt or grieve us *there*. *There* everything is pure and excellent and perfect, like its Maker, and the mind may range freely over its unlimited extent and variety, without pain or fear or disappointment, and contemplate each object,—around, beneath, above,—with feelings of unmixed gratification, admiration, and delight. There is a grand repose, too, in nature, which insensibly communicates itself to the mind of the searcher; and in the active but silent working of the great powers around us, the solemn grandeur with which many of them are performed, soothes while it awes, and delights while it instructs. This is specially the case in the contemplation of the heavens, or the region of the stars, from whence no sound is ever heard, save (occasionally) the solitary explosion of some distant meteor as it enters our atmosphere; but it is not limited to that department. The equally silent cloud that sails by, like a huge iceberg in the blue ocean above, is as impressive and delightful to the lover of nature; and so it is with the fauna and flora of our world, the animal creation and zoological department, or the earth's garden in which they have been placed. These, embracing as they do either the wonders of natural history seen in the living animals around us now, or the still greater marvels of the past unfolded in the records of geology,—these are ever

new, ever wonderful, and delightful and tranquilizing to the mind. Let any one whose tastes so incline him pass from the busy hum of man and the running stream of human life, with its cares and anxieties, its passions and its follies, its crimes, its trials, and its troubles, and they will find an immense relief in friendly, pure, and silent nature. The astronomer will straightway forget his griefs as he stands under a midnight sky beside his telescope, and seeks in the vast deep of heaven's infinity above for his favourite object. The meteorologist, or the chemist, too, as he analyzes the atmospheric world around him, in which he is himself enveloped, and tests its nature and properties and qualities, or examines its wonderful mechanism,—or the zoologist, who marks the moving living things around him, from the majestic tread of the stately lion in the forest to the crawling of a caterpillar, or the soaring of the eagle to the rapid flutter and colour of a butterfly's wing,—from the upspringing of a single lark from the green sod to the migratory flight of thousands of birds,—or, like the amiable and accomplished author of the *Natural History of Selborne*,* who, as he walks in his garden each morning, delights to trace the habits and history of every little bird that twitters from the shed, or sings on the

* "*The Natural History of Selborne*," by Rev. Gilbert White, A.D. 1744.

tree-top, or nestles under his friendly eaves. Thus he sings of it himself :—

"On the dark, still, dry, warm weather in winter."

"High in air, and poised upon its wings,
Unseen the soft enamour'd wood-lark runs
Through all his maze of melody : the brake
Loud with the blackbirds bolder note resounds.

"Soothed by the genial warmth, the cawing rook
Anticipates the spring, selects her mate,
Haunts her tall nest-trees, and with sedulous care
Repairs her wicker eyrie, tempest torn.

"The ploughman inly smiles to see upturn
His mellow glebe, best pledge of future crop ;
With glee the gardener eyes his smoking beds :
E'en pining sickness feels a short relief.

"The museful sage, abroad he walks
Contemplative, if haply he may find
What cause controls the tempest's rage, or whence,
Amidst the savage season, winter smiles."—

GILBERT WHITE.

All these beautiful pages of nature are open equally to the delighted readers, and are illustrated by the great Architect of our world with the gorgeous colours and artistic skill and perfection which alone belong to the Builder of the universe, and which men in vain endeavour to imitate ; but which furnish, too, an unceasing fund of information and delight, ever new and ever fresh.

To such studies and contemplations the writer of the following work would humbly desire to lead his readers,

however imperfectly. If it should serve, in some little measure, as a handbook to the three great departments it treats of, or impart to his readers half the pleasure which he himself has experienced in the search, he will be amply repaid the labour it has cost him.

The work has been mainly the result of much thought and personal observation of what is described : the experience of many years. Nevertheless the author desires thankfully to acknowledge the valuable information and suggestions he has obtained from the works of other writers. "Tell me, ye learned (says the witty and sarcastic author of *"Tristram Shandy"* *), shall we for ever make new books, as apothecaries make new mixtures, by pouring only out of one vessel into another." The following work does not profess to be any exception to this charge, which indeed is more or less applicable to every work that has been written, not even the sacred writers themselves being altogether free from such an imputation ; † such a course being as necessary as it is legitimate,—in truth "there is nothing new under the

* *"Life and Opinions of Tristram Shandy, Gent.,"* vol. v., chap. 1, by the Rev. Laurence Sterne.

† Vide Joshua x. 13 ; 2 Sam. i. 18 ; Numbers xxi. 14 ; 2 Chron. ix. 29 ; Acts xvii. 28 ; Titus i. 12, 13. Fourteen different authors and their works are referred to or quoted by the writer of the second book of Chronicles, and which are not included in the Jewish canon of Scripture.

sun,"—and from the storehouses of science the wondrous facts already discovered and recorded by great minds must be taken and used and applied in every new work. It is only in the mode of application of such facts that one scientific book differs from another. In this way possibly the following work may differ from some, particularly in reference to the Christian standpoint from which the author desires to view the subject of which he treats. This may have a novelty and interest for many which a purely scientific treatise would not. The author is quite conscious indeed of his own inadequacy to do justice to such a large subject as he has undertaken, and which he would not have ventured to attempt at once; but being written at different times, as separate papers, many of which have already appeared in the pages of one of the leading religious periodicals,* a considerable portion of the work had therefore only to be collected for publication, while he has availed himself freely of the labours of other more able writers than himself, to whom he desires to render his grateful acknowledgments. Among these, specially his thanks are due to Mr. R. Proctor, from whose delightful work, "Other Worlds Than Ours," he has derived most valuable information and suggestions. Also to Mr. Mathieu Williams, to

* The *Sunday Magazine*.

whose able and most interesting work, "The Fuel of the Sun," he is largely indebted. He also has to thank Mr. Nasmyth for his interesting and beautiful delineation of the planet Mars, as seen with his powerful telescope, which, with Mr. Proctor's admirable map, which he has kindly permitted the author to use, leaves nothing to be desired by those who wish to investigate the geography of that distant and interesting world correctly. To Mr. Browning also, the eminent London optician, the author's grateful acknowledgments are due for his two beautiful drawings of Jupiter and Saturn,* as seen by him with his silvered glass reflector; and lastly, to Mr. C. Burton, for his valuable information respecting the crater Linné, as well as the drawings of that remarkable crater, which he has so kindly furnished him with. To Messrs. Proctor's and Williams' novel views respecting the planets Jupiter and Saturn, the author has found reason to demur, though agreeing in the probability of the general truth connected with them. Reasons for so differing from those able writers on these points being fully given in the following pages, it is unnecessary to refer to them here, further than to say that it is not from any reluctance to give up an old theory, or a groundless conservatism as to the acceptance of a new

* Published by the Royal Astronomical Society in their monthly notices.

one, for he is quite open to conviction, but as he conceives to the want of sufficient evidence in the case of bodies situated at such a vast distance. To Mr. Proctor and Mr. Williams, however, is due the credit of ventilating, with great ability, a subject which must be of deep interest to all astronomers.

The author desires to commend the following little work to the care and blessing of the great Author of all it treats of, praying that the wonders of creation so imperfectly described may yet tend to the glory of His name, by inducing some who may read it to do what possibly they have not yet done,—viz., search the book of Revelation as well as nature, until haply they find the Almighty author of both to be one and the same Jehovah; while to others, who already have received the testimony of these two witnesses, he prays the perusal of it may be as though they were passing, like the high priest of the Jewish temple of old, through its different courts,—from the first court in the grand temple of nature to the second, and from thence to the holiest of holies, even heaven itself, the stately palace of the Most High, the seat of His glory and of the happiness of His people.

J. C.

Rectory, Violet Hill, Florence Court.

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Introduction.

THE purpose of the author in the following work will be seen in its opening pages, when a visit to the "three-fold heaven," referred to by St. Paul, is proposed to his readers, and presented in a popular form. The kind and favourable reception given to a former little work of his, * some years ago, has induced the author to put together in the following pages the fragments of his experience acquired since then in a more extensive sphere, and with reference to wider and grander departments of nature, but with the same design and object as in his former work: viz., to interpret and trace, in the glory and beauty of the scenery through which the reader who accompanies him must pass, and in the ingenuity and skill of the mechanism he beholds around, in sky, in cloud, in star, in planet, the work

* "The Lunar World, its Scenery, Motions," etc., considered with a view to design. A. and C. Black, Edinburgh.

of His fingers who made them all. It is this that lends a charm to such an investigation.* In the world of nature is a rich mine, but pure scientific investigation alone cannot draw forth its gold: however necessary and useful purely scientific treatises are for supplying information to the mathematician or the physicist, to the general reader, especially one who believes in the book of Revelation (and for such the following work is principally intended), such treatises are unsuitable. He feels the world of nature, however wonderful, to be a lonely world to walk through unaccompanied by its Maker, without any reference to Him, without perceiving His hand or hearing His voice. He hears the latter in the song of the thrush, or the robin that sits on the spray, as well as in the peal of thunder that rolls its echoes through the world. He sees the former as plainly in the sparrow's fall as in the planet's orbit, in the shadowy cloud that passes as in the mighty Sun that dissolves it. Nature, in every de-

* "If one train of thinking," says Paley, "be more desirable than another, it is that which regards the phenomena of nature with a constant reference to a Supreme and Intelligent Author. To have made this the ruling, the habitual sentiment of our minds, is to have laid the foundation of everything that is religious. The world itself thenceforth becomes a temple, and life itself one continued act of adoration. The change is no less than this: that whereas formerly God was seldom in our thoughts, we can now scarcely look upon anything without perceiving its relation to Him."
—Paley's *Natural Theology*.

partment without God, is to him as our planet without its sun. He treads a cold and cheerless region, however beautiful to the eye, and the universe becomes but a piece of self-acting mechanism,—a body without a soul. That such is the case, however, nature herself strenuously denies, while Revelation amply testifies to the contrary. And it is the unhappy divorce of these two books,—nature and Revelation,—by the many followers of science in the present day, and the consequent separation of science and religion, that has, in the opinion of the writer, conduced much to the disastrous scepticism, and materialistic atheism that prevails and is characteristic of the present age. What God has joined no man should put asunder; and it is the belief of the writer that while this unnatural separation has led from partial scepticism even to the denial of all religion, and the personality of the Creator, on the part of some of our most distinguished men of science, the united and joint evidence of *both* witnesses would, if admitted, bring overwhelming evidence to the contrary. It is, as in the case of two witnesses in a court of justice: different kinds of evidence are supplied by *each*, but both are equally needful, and one supplements the other. Thus we shall find that many of the problems and mysteries which cannot be solved by nature are resolved by Revelation, and *vice versa*. Nor

are the apparent contradictions and opposition between the discoveries of modern science and the statements in the Bible (as for instance in reference to geology, or astronomy, or anthropology) of any weight, so long as the great questions which are connected with human discovery remain incompletely answered, still fallible and undemonstrated, and their depths not fully sounded,—which is the case, and must ever be so when human knowledge is the only sounding line of nature. How many theories of science,—advanced within the present generation with all the confidence of certainty,—has the writer lived to see overthrown and abandoned, under what is called the *superior light* of modern science! Whether it is superior in every case remains to be proved. Yet not so the facts contained in the books of the Old and New Testament; they have stood the test of thousands of years, and still remain as the best and the only moral teachers of mankind, and though not intended to *teach science unless casually* and in a popular form, yet the popular science the Bible *has* taught,—although impugned and attacked,—has never been really overthrown, or proved to be false. To that Book therefore the writer confidently and constantly appeals throughout the following work; the purpose of which is three-fold: first, from among the first and second heavens, the region of sky and stars, to trace the design and purpose of their

Maker,—to see the hand that is Divine through all; and further, believing as he does that one God is the Author alike of *nature* and *Revelation*, to exhibit the wonderful analogy which exists between them, and to show that if the heavens be described in the Bible, the great truths of the Bible are written equally in the heavens, as well as on the earth; that the mighty agencies unfolded in nature present symbols and illustrations innumerable of the great spiritual truths taught in the Scriptures, and illustrated with a force and felicity of expression that no mere statement of doctrine could give, and an aptness and intentional fitness for each other that would be well represented by the fitness of a key for a lock and a lock for a key.

Thus the key of the Scriptures opens the lock of nature, and *vice versa* the key of nature turns the lock of truth in the Bible. It is for this reason, doubtless, that our Lord so frequently drew upon the great bank of nature and the agencies connected with it, for the purpose of illustrating spiritual truth. Thus an evening cloud could not glow in crimson beauty in the heavens, nor a shower fall from it on the earth—(Matt. xvi. 2; Luke xii. 54), the sun could not gild the Temple with his morning rays,—but straightway these familiar sights and beautiful processes of nature furnished food for instruction. (John viii. ; v. 2—12) In the world

of life around Him, too, the bird of the air could not fly past (Matt. vi. 26), a sparrow fall to the earth (Matt. x. 29—31), or a raven croak from a tree to her young (Luke xii. 24), or the silver-scaled fish of Gennesaret lie gasping on the shore (Matt. xiii. 48), but another volume of truth was opened for His hearers. Wherever He turned it was the same. From the grass that sprang green at His feet to the lily that bloomed there in its glory (Luke xii. 27, 28),—the fig tree that budded and blossomed by the wayside (Matt. xxi. 19), or the vine that clustered over the ruined arch or covered the dwelling of His workshop at Nazareth (John xv. 1),—all were used. Nothing in nature escaped His observation, or failed as a perfect vehicle and representation of truth. And so with the active human or Divine agencies at work around Him: the sower sowing the seed, or the seed itself springing and growing, reapers gathering in the ripe corn or threshing it,—the fields white with a pure harvest or crowded with tares and weeds,—all alike were pressed into the service of Him who made them and ordained them, and used in turn as it served His purpose, but presenting in all the most wonderful and perfect picture of the analogy which exists between *nature* and *grace*, between the world without and the world within.

The writer likewise touches upon the mysterious but

deeply interesting question of a plurality of worlds, taught, as he conceives, by both the heavens and the heavens' Lord, in His Word. Notwithstanding our ignorance *astronomically* of how many or which of the planets are now inhabited, the statement of our Lord in the fourteenth of John declares positively the existence of many mansions or dwelling-places there, while other parts of Scripture dwell upon the existence of numerous intelligent beings besides ourselves, who have left their dwelling on high to visit us. The truths thus suggested by astronomy are confirmed by Scripture, and lend an interest to researches in the heavens and the observation of the planetary worlds there, which they would not otherwise possess. From the consideration of a plurality of worlds it is but another step to that of the existence of the third heaven. Here astronomy and Scripture seem to have combined, and agree, each lending their own peculiar evidence to this grand conclusion. How far the writer has succeeded in elucidating this, one of the cardinal truths and doctrines of Christianity *astronomically*, he leaves for his readers to judge. The evidence of astronomy to that great truth, however, he would remind his readers is more *suggestive* than *demonstrative*, and, however interesting to the thoughtful mind, can at the most be only a matter for reasonable speculation. The great fact and doctrine

of the existence and reality of a "heaven of heavens," called by St. Paul the third heaven, is not, however, dependent upon astronomy or science to prove it: its truth and certainty can only be a matter of revelation. How far, however, it is legitimate to supplement *revelation* by *natural theology*, or, as it may be termed, the *theology of nature*, and *vice versa*, or to bring the discoveries of science into harmony and agreement with the truths and doctrines of the Scriptures, let the great Christian apologist* again reply:—

"These points being assured to us by natural theology we may well leave to revelation the disclosure of many particulars which our researches cannot reach. The true theist will be the first to listen to any credible communication of Divine knowledge. Nothing which he has learned from natural theology will diminish his desire for further instruction, or his disposition to receive it in humility and thankfulness. He wishes for light, he rejoices in light; his view and veneration for the Great Being will incline him to attend with the utmost seriousness, not only to all that can be discerned concerning Him by researches into nature, but *to all that is taught by a revelation which gives reasonable proof of having proceeded from Him.*"

How different is such reasoning from the senseless atheistic Materialism advocated by more than one of

* Paley.

our distinguished scientific physicists of the present day, who not only reject the evidence of the Scriptures but the idea of a personal Deity exercising control and supervision over all nature! It is the fashion of the present day to decry Paley, his evidences, and his theology, and to term it contemptuously anthropomorphism (*i.e.*, belief in a God resembling man); and yet what is there of argument in this term of reproach? What is there irrational in the belief in a Personal Intelligence resembling man and man resembling Him, so far as, in the intelligence *he* possesses, a creature can be supposed to resemble its almighty Creator? Christianity at once affirms the fact in the case of "the first Adam, who was made in the image of God, as also in the last Adam, or God Himself, who appeared among us in the image and likeness of man," the God man, Christ Jesus; those who term the theology of Paley *old-fashioned*, and *anthropomorphic*, have never yet replied successfully to his arguments for a personal Deity, derived from proofs of design. That argument, illustrated by the well-known illustration of a watch, has never been answered, and remains at the present day as unanswerable as it is unconquerable: such anthropomorphism as Paley proves from that argument is, in fact, the glory of the Christian. But what has been substituted for it by the Materialists of the present day? They would teach us that while

they acknowledge certain great powers running through nature and accomplishing wonderful things, they are not the result of the exertions of an intending contriving mind, but resolve all productions into unconscious energies; that the universe is replenished with particles endowed with life, but without organization or senses of their own, and endowed also (by whom or what they do not say) to marshal themselves into organized forms; and that the concourse of these particles or atoms by virtue of the tendency, but without intelligence, will, or direction, have produced the living forms which we now see. Such is the system of atomic, atheistic Materialism; in which, indeed, there is nothing new, and the atomic theory of Professor Tyndall does not differ much from the organic molecules of Buffon.*

One thing, says Paley, all such philosophers agree in: viz., the endeavour to dispense with the necessity for a particular Personal Intelligence. How far such a conclusion is *probable*, or indeed *rational*, let the same eminent philosopher tell us. "Every indication of contrivance, every manifestation of design, observable in a watch, says Paley, exists in the works of nature, with the difference on the side of nature being greater and more, and *that*

* *Vide* "An Examination of the Belfast Address of the British Association, 1874, from a scientific point of view." By John Eliot Howard, F.R.S. An able reply to Professor Tyndall. London: Hardwick and Co.

in a degree which exceeds all computation. I mean that the contrivances of nature surpass those of art in the complexity, subtlety, and curiosity of their mechanism, and still more, if possible, do they go beyond them in number and variety; yet in a multitude of cases are not less evidently *contrivances*, not less evidently *accommodated to their end*, or suited to their office, than are the most perfect productions of human ingenuity." But should the Materialist reply, "This is but the operation of *law*, which is eternal, and the existence of which no one *denies*,"—be it so. But surely it is a perversion of language to assign any law as an efficient operative cause of anything. A law presupposes an agent, for it is only the *mode* according to which the agent proceeds; it implies a *power* likewise, for *it* is the *order* according to which that power acts. Without this agent, without this power, which are both distinct from itself, the law *does nothing, is nothing*.

Of one thing, therefore, we are certain: whatever the Deity be, neither the universe nor any part of it which we see can be He. The universe itself is merely a collective name: its parts are all that are *real*, or which are *things*. Inert matter is out of the question, and organized substances include marks of contrivance. Whatever in its constitution testifies *design* necessarily carries us to something beyond itself,—to some other

Being,—to a Designer, prior to *and out of itself*. No animal, for instance, can have contrived its own limbs and senses,—can have been the author to itself of the design with which they were constructed. Whenever, therefore, we see *contrivance* and the adaptation of a means to an end, we are led irresistibly and inevitably to an intelligent Author and Contriver. And if it be asked, “Since *something or other* must have existed from eternity, why may not the present universe be that something?” The reply is: “The contrivance in it proves it to be impossible. Nothing contrived can, in a strictly proper sense, be eternal, forasmuch as the Contriver must have existed before the *contrivance*.” In this view nothing is gained either by moving the difficulty further back, even through an infinite series of mechanism. Where there is mechanism there is contrivance: contrivance is still “undiscovered, for *we still want a contriver*, an intending hand,—an adapting hand,—the intelligence by which that hand was directed.”* It is to be deeply lamented that reasoning so conclusive and unanswerable should be treated with neglect and contempt by the sceptics of the present age,—many of whom have never read it, who for the sake of originality of thought, perhaps, or dislike to remain in the

* Paley’s “Theology,” chapter ii., page 11.

orthodox grooves of popular opinion, are ready to sacrifice truth to the wildest and most groundless theories, theories which have been advanced and oft refuted before the present generation were born.

The author of the following pages, therefore, while apologizing for the introduction of what in a popular treatise may seem unsuitable, yet in a work professing to deal with the great agencies of the universe, from a point of view not generally adopted in scientific treatises, he has found it necessary to refer to and repel opinions calculated to do injury to the noble branches of science of which he was treating, and which unfortunately he fears are current,—not on the surface of society merely, but, he is persuaded, deeply in the thoughts and minds of many highly gifted and sincere, amiable men, who have yielded to the popular stream of a godless Materialism, so far as to exclude the religious aspect from works of great scientific value in other respects. If the calm contemplation of the wondrous mechanism exhibited in the first two great chambers of the great exhibition palace of nature into which his readers shall be introduced,—if a glimpse of the wondrous working of air, and cloud, and sea, and sky, and bird, and star, and planet, feebly and inadequately rendered as it is by the writer,—shall have the effect of convincing a single mind, that has not yet been convinced, of the

folly and irrationality of such Materialism, or produce the conviction of a *personal, intelligent, all-powerful, and gracious Being*, creating and sustaining all the great agencies around him, all he sees or hears, and leads him finally to worship and adore their Author, as exhibited in Christian anthropomorphism by God in the *likeness of man*, the author will be more than repaid.



THE FIRST HEAVEN,

OR

WORLD OF AIR.

THE FIRST HEAVEN,

OR

World of Air.

CHAPTER I.

THE AIR.

"Lo, the poor Indian, with untutored mind,
Sees God in clouds, and hears Him in the wind."
POPE.

THE expression "heaven," as applied to our atmosphere, is essentially Jewish as well as Eastern.

Many of the Jewish Rabbis held that there were seven heavens. St. Paul refers to three heavens (2 Cor. xii. 2), doubtless in the same sense in which his countrymen were in the habit at that time of applying it. Six hundred years after Paul, Mahomet, in constructing the fable of his celebrated night journey from Mecca to Jerusalem, revived the old Jewish idea of the seven heavens, through which he professed to have passed. This old Jewish notion, it need scarcely be said, was a tissue of absurdities, quite as bad as Mahomet's, which was thus founded upon it. Not so, however, the doctrine held upon this subject in the Apostle's day. The

heavens were divided then into three: first, the ærial, or atmospheric, in which birds fly, clouds and showers are formed, and winds blow; secondly, the starry heavens, or the regions of space, in which the sun, moon, and stars are disposed; and, lastly, the heaven of heavens, or third heaven, referred to in the passage already mentioned by St. Paul as the abode of the blessed and of the holy angels, and the special residence of the Most High.

This division is not only natural and unobjectionable, but according to fact; and while it rescues the word heaven from the confusion of ideas often entertained by the use of that word, each department will afford an interesting topic for the consideration of those who love such subjects, respectively; while, as the doctrines of the Christian faith lead us to believe that we ourselves shall one day pass through the first two as the great ante-chambers to the third,—in considering any one of them we shall be but, as it were, anticipating a part of our journey heavenward and homeward; for thither *our* home must surely be, where Christ our Lord Himself ascended, till a cloud concealed Him from view. Each of these departments, however, embraces a separate and distinct subject, bringing us, as we pass through them respectively, into the territories or provinces of the Meteorologist or Natural Philosopher, the Astronomer, and the Theologian; each therefore may and should be considered separately by itself: the object of the present paper being merely the first-mentioned.

Through a great portion of this, man has actually passed in the body, and though unprovided with wings, has soared to heights beyond that to which any bird has

attained,—and from the car of the balloon, seven miles perpendicularly from the surface of the earth, has explored these strange and silent regions, and, losing sight of the world he inhabits, has witnessed the mountains of a cloud-world rolling far beneath him, and piled in snowy heaps and fantastic pinnacles, to which the solid Alpine masses below are but molehills. But, curious and highly interesting as such ærial excursions must be to those who have nerve and head to engage in them, they have not added much to the knowledge of this region, already attained by accurate chemical analysis and observation before any such ærial chariot as a balloon was known. The result of such analysis and examination we now proceed to give in a popular shape.

Most of our readers are doubtless aware that surrounding our globe, and attached to it, is an ærial envelope, or ocean of air, that revolves with our planet as though it were a part of it, and which is called the *atmosphere*, from two Greek words signifying a sphere or globe of air.

Though lighter a good deal than water, air is yet of considerable weight, pressing down upon the earth, and upon us on every side, just as the ocean does on its bed and upon the fish that inhabit its depths.

It is, in fact, as much an ocean to us as the sea is to its inhabitants, and like the sea it is subject to violent agitations, having its own storms as well as calms; its own waves, and currents, and whirlpools; its own tides too, with their regular ebbs and flows. Like the sea, too, it has its own peculiar colour that belongs to nothing else, hence called sky-blue, as the green of the sea is

called sea-green; and though when seen through a short space this colour is invisible, yet when looked at through a long distance or depth of air it is plainly perceptible; and though its aerial waves are themselves unseen, yet we are assured of their presence plainly enough, as they roar through the woods or sweep across the watery surface of their companion ocean below, lashing it into responsive fury. As they thunder against the rough breast of the craggy mountains opposite to me, striking the corner of my house, or roll down the chimney, I feel, without any shadow of a doubt upon the subject, that there is a real, powerful, and invisible agent in the shape of an aerial ocean around me and above me on every side. Now what are its uses? Plunged in its cerulean depths as we are, this atmospheric ocean becomes the great breathing apparatus for us and all the animal world, and indeed the vegetable likewise. So essential to us is it, that were it removed from the earth for only five minutes, there would be an end to all life, and in a short time the earth would become a desert rock, like the moon, and we ourselves would be reduced to the state of the poor fish whom we have seen gasping on the bank, when removed from their watery atmosphere by the expert angler.

This, therefore, we may look upon as the main or chief design of our aerial covering, although it is true it subserves a vast number of other deeply important ends in the wondrous mechanism of our globe. These we shall consider in their place; but, before doing so, let us glance at the only account we have of the creation of this beautiful contrivance. It takes its place, then, in the Mosaic record as the very first thing created,—simul-

taneously indeed with the earth, as described in the first verse of Genesis; for, whether the word heaven, which the best Hebrew scholars say should be heavens, be taken in its more enlarged sense, as referring likewise to the second or starry heavens, which possibly it may, yet surely the first or atmospheric heaven cannot be excluded, indeed must be, I should think, principally intended. It is placed there, at all events, in its proper place, as the inevitable and necessary appendage to a planetary world intended for living and breathing creatures. It is true there is another and more special reference to its peculiar arrangement for watering the earth by showers; and in the second's day's creation, when that arrangement is fully explained (in the 6th, 7th, and 8th verses), where the aerial "expanse" is referred to under the Latinised name of "firmament," a translation which does not at all express the meaning of the Hebrew term; yet it is evident its creation took place long before this description, and must be referred back to the first verse,—where its existence is plainly implied on the first day, from two sources: first, from the expressions morning and evening, both of which intimate the gradual diffusion and as gradual withdrawal of light (or twilight), which could not be without the presence of an atmosphere; and secondly, from the statement in the second verse, where the Spirit of God is represented as moving over the face of the deep. There might be an atmosphere without water indeed, but there could scarcely be water without an atmosphere; while the expression "Spirit of God" is now considered by the best interpreters to refer not to the Third Person of the Trinity, but

simply the wind of God (*spiritus*): *i.e.*, the wind or atmosphere moving in its course over the as yet dark oceanic depths. In no department of creation, perhaps, is the wisdom and skill of the Divine Architect more conspicuous than in this, the first heavens of the Bible,—the wonderful ærial covering attached to us, and revolving continually with our globe in its diurnal motion, as it does, independently of its own proper movements; whether considered, indeed, in reference to its nature and composition, its varied qualities and uses, and the pleasures it ministers to the inhabitants of its depths—for it has quite as many inhabitants as the sea, if not more; whether we consider its beauties or its terrors, its uses or its delights, its creation is a marvel of God's handiwork, while its continuance for an hour is a miracle more stupendous than many Christian miracles that are denied in the present day of scepticism, and furnishes one of those striking proofs of Intelligent design, in its beautiful adaptation to the wants of the creatures it was intended for, that is irresistible in its conclusion that there is an all-wise and powerful Creator. But let us now inquire how we are enabled to reduce this impalpable and indefinite heaven to something tangible and definite, having substance and limited extent. How do we arrive at the notion of its perfect substantiality, when it is invisible and yielding, and of its definite boundary, without any apparent line of demarcation? Plainly, not from its colour, for though we know it possesses colour, it is no guide to us in this inquiry: though the sky is unquestionably blue, it is only when seen *en masse* that it is so; then, indeed, looking through its entire depths when the sky is cloudless, its colour comes out most

conspicuously, and one of the most beautiful sights in nature is—

“The spacious firmament on high,
With all the blue ethereal sky.”

But this colour totally disappears when in a small quantity: it is then colourless and invisible. Colour therefore gives us no exact gauge for measuring its extent or limit, nor assures us of anything but the fact that it is a property belonging to it and not to the higher regions, which we know because the blue colour gradually fades, and at length entirely disappears as we rise to great heights above the earth, either to the summit of a lofty mountain or elevated in a balloon, when the heavens above us lose their beautiful tints and become black as a pall above, while they continue still blue below. No line of demarcation, however, can, under the circumstances, be possibly fixed upon or defined by the colour of the air. Other colours there are which the atmosphere exhibits, but these are not permanent, but merely occasional and local, and arise from the introduction of watery vapour as an ingredient in its composition, and the refraction of the sun's rays in passing through it, by which (as in the rainbow) the white light of the sun is separated into its component parts or coloured rays. While the colour of the air, therefore, cannot assure us either of the definite boundary of our atmosphere or its substantiality, we have abundance of evidence of both from other sources.

The simple act of passing the hand through the air, or any rapid motion of the body, such as riding, or running, or travelling in a railway carriage with the hand extended from the window will assure us of the substantial nature

of air; we are at once made conscious of something resembling water in its feeling, but much lighter and less sensible. But, without moving at all ourselves, a fresh breeze or a storm at once assures us of its substantial presence, without the possibility of doubt, and from the gentle trembling of the aspen leaf to the upturned roots of the monarch of the forest, we perceive that we are enveloped in a substance that from a slumbering infant can become a terrible giant in strength and power.

Insensible as we are thus generally to its influence when undisturbed, yet its substantiality can be further proved by its weight, which presses upon us with a weight of not less than fifteen pounds to the square inch. This fact of its pressure was known before air was actually weighed and its weight ascertained. Aristotle even asserted that air had weight, and speaks of a bladder filled with air weighing more than an empty one; but this doctrine was abandoned by his followers in the middle ages, and it was left to comparatively modern days to revive the great truth propounded by that sagacious philosopher. The proof that air has weight was demonstrated about the close of the last century by the simple experiment of weighing a bottle containing air, in a scale, and weighing the same bottle again after the air had been exhausted from it by an air-pump. Having thus ascertained its weight, the inference followed as the inevitable conclusion,—that, like other bodies having weight, it exercises a proportional pressure upon everything it comes in contact with;—fortunately for us, however, this pressure is not exercised in one direction alone, but from all sides equally—from the *interior* of

our bodies (where it acts upon the fluids) as well as upon the exterior from without; so that, being supported as it were on every side, we feel no inconvenience from it, but are perfectly insensible to its pressure. Were a *fourth* part of the pressure it thus exercises upon us to be extended in one direction, as from above, we should be forthwith crushed to death upon the earth; as it is, however, we move freely through it,—the little child as well as the strong man alike insensible to the burden they bear. The weight or pressure of the air, however, is not always the same, and at the surface of the earth, where it is most dense, undergoes considerable changes;—this we know by the barometer, that curious and beautiful instrument in which a column of mercury or quicksilver balances its weight to a fraction, and reveals to us every variation of the pressure of this invisible agent, however slight, through every moment of time. This pressure and weight becomes less in regular proportion as we ascend to a height, the air expanding and becoming thinner as it expands, till at length it becomes so thin and light as to render it unfit for breathing, and finally, it is believed on good grounds, ceases altogether at forty-five or fifty miles from the earth; all this we have ascertained from the barometer alone, which indicates the slightest change, and thus becomes the measure of any height we may attain from the earth.

When ascending to the summits of lofty mountains, such as the Alps or Himalayas, or still higher in balloons, as was lately achieved by Mr. Glaisher and Mr. Coxwell, this gradual thinning and expansion of the atmosphere becomes painfully evident to the senses, and is accompanied by great inconvenience and not a little danger to

life. The fluids of the body experiencing less pressure from without, bleeding of the nose, deafness, singing in the ear, with other symptoms of a still more dangerous character from the unnatural dilatation of the bodily organs, producing insensibility and death, as nearly happened to Mr. Glaisher and his companion, warn us of the necessity for a denser atmosphere for our existence, and the wise and gracious arrangement through which this is secured to us permanently;—the denser parts of this fluid substance always remaining near the surface of the earth, being kept there in a state of condensation by the superincumbent and proportionally increasing pressure of fifty miles in height above it. The barometer, as it ascends from the earth, reveals to us, however, in a more agreeable and certain manner the gradual cessation of air, until we can calculate without difficulty the exact spot where it should cease, where its weight, at least, would be imperceptible, and, therefore, it is concluded, where there is no air or atmosphere. That point has now been decided to be about fifty miles from the surface of earth.* This indeed, we can perceive to be actually the case with other planetary bodies, the existence and limitation of whose atmospheres can readily be descried. But the design of our own ærial envelope becomes more apparent when we come to examine it chemically, both as to its nature and component parts, in connection with the uses it subserves.

* Recent observations of the height at which meteoric bodies first take fire (which is caused by their entrance to our atmosphere, and passage through it) has led to a somewhat more extended estimate of its limits, and from 80 to 100 miles has been assigned as the more probable termination of it—imperceptible indeed from its tenuity otherwise, but thus certainly indicated.

The air or terrestrial atmosphere is not, as was once supposed, one simple substance; it is composed of two great constituent airs or gases, together with several ingredients in smaller quantities and regular proportions. So skilfully mixed are these airs or gases by the Divine hand that prepared and provided them for us, as not only to be adapted perfectly to all the various purposes intended, but so delicately adjusted in their nice proportions that the slightest alteration of any one of those proportions or quantities would not only be deleterious to health, but disastrous to life,—would turn the healthful breeze we inhale with such delight to poisonous miasma, and prove immediately fatal to the whole animal and vegetable world.

The two principal or constituent gases of which our atmosphere is composed are nitrogen and oxygen. The term gas has been applied to these and others that make up the composition called atmospheric *air* which we breathe. They are termed *gases* only when in their separate condition, from a Saxon word, *gast*. They are, however, but different kinds of *air*, of which there are many, and though they all differ in many qualities and properties possessed by each, yet in other respects they are all alike, being all alike *invisible, transparent, colourless, light, compressible, and elastic*. Of a *union* of some of these gases, then, is our air, or atmosphere, composed; and the old and erroneous idea of the last century, that air was a simple, elementary substance, has long since been abandoned, its real nature being discovered at the close of the last century by Lavoisier, a celebrated French chemist.

The two great constituents of our atmosphere, then,

are *nitrogen* and *oxygen*; the former much the largest in quantity, being as 80 parts out of 100: *i.e.*, 80 parts of nitrogen to 20 of oxygen, or four-fifths of the entire. Now, neither of these airs or gases could be inhaled separately without causing death, though the mixture is the breath of our life. Nitrogen, indeed, would by itself cause instant death, such as is caused by foul air in a deep well or a vault, when a candle is extinguished when introduced. The other gas, oxygen, called vital gas, being that which seems to minister most to the activity of our vital power, though it could be inhaled for a short time with impunity, would, if persisted in long, terminate like the other, in death, exciting our system so violently as to produce inflammation of the lungs, and other evils to the circulation. Other gases are combined with them, but in small proportions, and not as constituents but as ingredients; some, indeed are so small in quantity as scarcely to be traceable. The most important among these are carbonic acid gas and hydrogen; the former, though proportionally small in quantity, occupies an important part in contributing to the life of the vegetable as well as the animal world, without which, indeed, neither could exist. This gas is breathed or inhaled by every plant, and flower, and tree, and exhaled or given out by them again by day and night; while we ourselves, though in its pure form it would prove fatal to us, yet breathe it in a mixed or diluted form continually in every crowded or ill-ventilated room, in every woodland walk, especially in the evening, while it is generated in our lungs at every breath we draw in, and exhaled or given out at every expiration. This gas or air is composed of the oxygen which we breathe, when

it is brought into contact with carbon,—a substance found extensively in both the animal and vegetable creation; it exists in every plant and every animal: all plants or animals, therefore, breathe or inhale the oxygen. When it reaches the lungs of the latter or the substance of the former, carbonic acid gas is immediately generated and given out again. Plants, trees, and flowers are themselves a mass of carbon; vast quantities therefore, of this gas are generated and given out by the vegetable world, but while man expires it or gives it out, he could not take it in, or inspire it undiluted, or to the extent that trees or plants do, without injury; hence the danger of crowded and ill-ventilated rooms, where the air breathed by so many lungs, and given out in the shape of carbonic acid gas, is so much poison, unless there is abundant ventilation for it to escape. It is true that we inhale it in a diluted form even then, or we should not escape with a simple headache, or that peculiar drowsiness that ever accompanies a crowded meeting; but the pale faces of those who night after night frequent such places, where many lights burning assist in consuming the oxygen, show pretty plainly the poisonous character of this gas, which is injurious just in proportion to its undiluted condition. For the same reason, living in forests, or walking much out at night is injurious to health, for night is the time when the vegetable world gives out in vast quantities the oxygen they have received in the day, in the form of carbonic acid gas; and to sleep with many flowers in the bedroom is no idle or superstitious prejudice or vulgar error; every geranium-plant is a distilling poison at night, though comparatively harmless in a room by day. This gas is considerably

heavier than either of the constituents of the atmosphere, and may be reduced by pressure or reduction of temperature to a liquid or solid.

Hydrogen also forms an important part of the vegetable and animal world; one of its chief properties is its highly inflammable nature: it burns with a strong blueish flame; when united with oxygen it explodes; it is much lighter than any of the other gases, and was employed, and still is in an impure form, for the inflation of balloons, by means of which the present aeronautical system has been established. Other gases likewise are traced, but in very small quantities, and among them watery vapour, or the waters of the sea, in various stages of condensation, from an invisible gaseous state to clouds of every density. And here a great truth or fact is revealed in this view of our atmosphere: viz., that nothing is annihilated that has been created, but only assumes a different form; the destruction of matter in any form, indeed, being impossible. Thus, all decomposing matters which seems to us to disappear, such as the carcases of animals, etc., or our own bodies, are not destroyed, but simply resolved into their several original gases. The human body for instance, consists of all the gases in the atmosphere, with carbon and other substances peculiar to itself; each of these at dissolution is set free, and takes its proper place in our atmosphere, or unites with those vegetable or animal substances for which it bears an affinity, re-appearing either as an invisible gas or vapour, and re-entering the substance of some solid body in the vegetable or animal creation. Our atmosphere thus viewed, appears to be a vast sewer, or channel for dissipating all noxious and unwholesome

vapours and effluvia and dangerous nuisances, which would be the inevitable result of the continued decomposition of millions of human beings, and other animals, as well as the decay of the vegetable world, which would in a short time poison the entire globe with its inhabitants; while it may likewise be viewed as a great chemical laboratory or workshop, in which the most wonderful transformations are effected by a great circle of changes, such as no fairy tale ever exceeded; in which solid is changed to gaseous or fluid, and *vice versa*, invisible to visible, and the reverse: the very bodies of our friends, passed away from sight, still possibly floating around us, in the form of invisible gas, or passed into the substance of a tree or a flower. Strange and wild and fantastic as this idea may appear at first sight, it is yet a great chemical and cosmical truth, demonstrable as any other indisputable fact of natural philosophy, and may be proved as certainly as any proposition in Euclid. Nor does this detract, as some might suppose, from the wonderful doctrine of the resurrection of the dead, but on the contrary, seems to confirm it in the most striking manner, proving that there is no such thing as annihilation or death, strictly speaking, here; the dissolution or decomposition of any body being merely its change or transformation to another form and state of being. True, without the exercise of Divine power, the subtle gases which form the human frame of man would not rearrange themselves as before. This fiat, therefore, is needed: but surely He who has commanded every separate gas contained in our ærial covering to know its own place, and perform its own work, and retain its own properties, and undergo its own transformations,

can have no difficulty in changing and transforming, any more than He had in originally creating, the strange accumulation of gases termed the human body, into another of a different constitution, more perfect, and more glorious, and adapted for a new state of being.

CHAPTER II.

CLOUDS.

"Can any understand the spreading of the clouds?"—JOB XXXVI. 29.

LIVING as we do in a climate where we are constantly "in nubibus" (in the midst of clouds), so that a blue sky is a comparative luxury and rarity, it may be thought we are acquainted with these familiar objects well enough already,—too well, indeed, for our comfort sometimes; and that the scientific study of them, although it can hardly be a dry subject, yet cannot be very interesting. To the real lover and observer of nature, however, there is not in any department of it, among the many wonders by which we are surrounded, anything more wonderful, or worthy of our close attention and study, than the cloud world, as we may call the vast assemblage of those strange-shaped and familiar objects, ever created afresh before our eyes that they may vanish again, ever coming that they may depart, ever rising that they may fall again, ever fleeting, yet still the constant companions and permanent attendants of man, and faithful satellites of the earth,—our nearest neighbours in the heavens, and if we will believe it, our steadfast friends and obedient servants, intended to do us good, though sometimes, but seldom, working us ill. The very circumstance that millions of people

are looking at them every day, who yet know nothing about them, except as prognostics of the weather, or as disagreeable companions, should induce us to inquire more closely into their real nature and uses, and the design or purpose to be discovered in them. And certainly amidst all the wondrous mechanisms by which our planet is sustained in its present condition, that of the cloud world is perhaps the most astonishing and beautiful,—the services rendered us are the most necessary and important.

Clouds, as we have said, are the satellites, or servants, of the earth,—the very slaves and drudges of our world. Ever restless, ever moving, they never cease their work: if not “hewers of wood,” it will be acknowledged they are constant “drawers of water,”—nor is the former appellation altogether without some truth, as many an ancient oak tree can attest to the thunder-cloud that has riven him. But to us they are as needful as domestic servants are to the rich: nay, more needful and more useful; for they are servants to the poor as well, and charge nothing for their valuable services. And if the choice were given us as to which we could best dispense with,—our single satellite, the solid moon, or our innumerable host of black and white slaves,—our cloudy, soft, shadowy servants, that present themselves every day before us to work for us, like the genii of Aladdin’s lamp,—there is little doubt as to which we ought to give the preference, or which would be most needful for our existence, not to speak of our comfort.

There are planets, such as Mars and Venus, without any moon, and therefore so might the earth have been: as far as moonlight is concerned, it is but partial, and

might be dispensed with; while as regards the ocean tides, which the moon regulates in company with the sun, her part in this matter might easily be deputed to our great and more powerful luminary. But, except the moon herself, there is no planetary body that we can perceive that seems destitute of clouds; and for this reason,—that their existence would seem to be absolutely necessary for the maintenance of life: *i.e.*, arguing from analogy with our own circumstances, and assuming that the laws of the creation are the same everywhere. Thus, were the clouds withdrawn from the earth, for instance, the whole vegetable world would immediately perish, and with it the animal world that is dependent upon the vegetable world for their existence. Nay, more, were there no clouds ever to be seen on the earth, there would necessarily be no water upon its surface,—no oceans, rivers, or lakes: in fact, it would be a lunar world, a desert rock; for where water is alone will clouds be found, which are but the bottles of heaven, filled from the earth’s oceans, and discharged, by a most wonderful and skilful contrivance, upon the dry land. They are the servants, who respond, in the words of David, when “God calleth for the waters of the sea, and poureth them out upon the earth.”

We may argue, therefore, for a certainty, that there is no water in the moon, because not a cloud has ever been seen to dim the sky of that barren world, and hence we conclude that there is no life there. Not so, however, in Mercury, Venus, Mars, and Jupiter, or Saturn: not only can clouds similar to those of the earth be seen on those planets,—sailing by, coming and going, breaking up, or condensing, rising from, or descending upon their

oceans,—but some of the peculiar functions discharged by our clouds here may be perceived there in action; as in the planet Mars, for instance,—now discharging snow showers, now congealing in hoar frost, now presenting dark patches of moving rain clouds, like our own.

Hence the consideration of the cloud world in general,—their number, their varied and changing forms, the beauty of their appearance, and their wonderful functions, cannot but prove an interesting subject of study and contemplation for the man of science; while to the Christian, who sees his Maker's hand in all around him, the wisdom displayed in the mechanism by which they fulfil the purpose and design of Him who made them, cannot but be a subject of admiration and praise. Shadowy, unsubstantial, variable things as clouds are,—seeming to own no law, but scattered broadcast upon the heavens, yet obeying strictly and carrying out perfectly their instructions, as though they were men, and not vapour, as though they were iron steam engines, and not soft clouds,—they appear as a well-disciplined army, obeying the word of command from their General; every separate cloud now performing its own task, now the whole army advancing together or retreating, till their work is accomplished. Such a command to the insensate creation, and specially to the heavens, meaning doubtless these vast repositories of rain, is described by the Prophet Hosea, in God's own words: "It shall come to pass in that day, saith the Lord, I will hear the heavens, and they shall hear the earth; and the earth shall hear the corn, and the wine, and the oil; and they shall hear Jezreel."

Here is the great wheel of Nature and Providence revealed at work. The coherence of second causes one with another is here represented as links in a chain; and the dependence they all have severally upon the Creator, as the Great First Cause: thus,—God's people call to the earth for corn and wine and oil in the famine. But the earth cannot give them without rain; therefore she calls to the heavens for a supply. "But," says the heavens, "we have no rain to give, unless He who has the keys of the clouds unlocks them,—unless He that commandeth the clouds opens their bottles, and tells them to pour out water." The heavens then call to God, who immediately notices their complaint. "I will hear the heavens," saith the Lord (*i.e.*, I will answer them); "and they shall hear and answer the earth, and pour seasonable rain upon it; and then the earth shall hear the corn and wine, and supply them with moisture; and they shall hear Jezreel, and thus supply nourishment and refreshment to my people."

Looking then at this cloud-world, let us first direct our attention to it from a scientific point of view; considering their nature and composition, their formation and appearance, as gathered from observation,—distinguishing them according to the classification by which eminent meteorologists have divided them (so far as is possible, at least); the extraordinary mechanism also by which they discharge their functions, and the design so apparent in the entire system.

We shall *then* consider them in reference to the miraculous part which clouds have performed in the history of the Old and New Testament, where we find them connected so frequently and so directly with the

power and presence of Jehovah, and as instruments in His hand for the preservation of His people.

There is as great a variety in the appearance of clouds and their disposition in the heavens, as there is in their number, which is incalculable at any one time, when the sky is crowded with them, even within the bounds of our horizon. The sum-total of clouds ever resting on or floating over our planet must be enormous,—past imagination. Their magnitude also varies as much, some clouds being vastly larger than the greatest mountain on the earth; and when thrown into groups, or cloud-chains, rivalling the Alps or Andes or Himalayas; while others are so small that, were they solid, they could almost be held in the hand.

Various attempts have been made to classify them by meteorologists, and with considerable success. But though their ever-changing appearance is so different, and their composition is found to vary, the substance of which every cloud is composed is mainly or essentially the same,—water being the chief ingredient, though existing in them in a great variety of modification and quantity; from the light and apparently dry and filmy gauze vapour, to the blackest and densest thunder-cloud or watery shower-bath,—from the apparently solid white mountains of stainless snow or wool, that seem motionless as the terrestrial giants beneath them, to the light drifting mist that hangs midway between the craggy hill-top and its base,—or the flying scud that hurries by on the wings of the wind at 50 or 100 miles an hour,—all these have their own different densities and ingredients, electricity forming a most frequent and essential one; but all are of water in some form or other as their basis,

in a condition called aqueous vapour,—not altogether yet understood, and quite distinct from its normal and simple condition of water.

How it is that a cloud is formed at all from the clear air, and (being formed) retains its definite shape distinct from the surrounding atmosphere even for ever so short a time, is a problem that has never been fully solved. In the time of the Patriarch Job this fact excited the attention of Elihu, who evidently was not ignorant of the nature of clouds, and thus expressed his knowledge of what they were, and his admiration at this fact: "He bindeth the waters in His thick cloud, and the cloud is not rent" (*i.e.*, retains its form.)

What is the mysterious power that does this,—that first forms, and then keeps a cloud suspended in a distinct and definite shape in the clear sky?—was the problem then, and with all our advances in science, is still so. Various conjectures and theories, it is true, have been made by scientific men to account for it, and some of them sufficiently plausible and interesting. Yet though the immediate cause of their formation is known (at least partially, for even it is not perfectly ascertained), yet the actual transition from clear vapour to the cloud-condition cannot be followed or traced by any human being, nor thoroughly understood; while the assuming and maintaining a definite form for the same reason is, in a great measure, an equal mystery. So likewise with regard to their change of shape: to this, too, the attention of Elihu was called; and accordingly he inquires, "Can any understand it,—the spreadings of the clouds?" (*i.e.*, the power or process by which they alter their shapes and disperse themselves over the earth). By which

is meant not so much their dispersion by the winds of heaven (though that is a beautiful arrangement too) as the unfolding themselves, as it were, and expanding themselves over us by some secret operation; and by which their original form is changed. Even in the present day this cannot be satisfactorily accounted for. Though the wind is a powerful agent in their dispersion, yet it has nothing to do with their own enlargement or diminution, which is due to other causes not clearly ascertained. Thus often a cloud no bigger than a man's hand (as that described by the prophet's servant) will (as that he beheld did) spread itself till the heavens become black with clouds.

But the formation of a rain-cloud, which is found to consist of minute vesicles (drops of water), which when exposed to certain influences become large and heavy, and can no longer retain their places in suspension in the air, but descend in copious rain,—this too is another mystery only partially solved or guessed at by modern science,—the *fact* being known in the days of Job, while the *cause* was unexplained, and attributed to the direct action of the Almighty, without assigning any secondary cause, thus: "He maketh small the drops of water; He poureth down rain *according to the vapour thereof*" (*i.e.*, rain proportioned in quantity to the quantity of vapour). *This* is a scientific fact *so far*, and it remained for science of more modern times to endeavour to explain it more fully: how far it has succeeded is questionable. The explanation that is now given it must be acknowledged is not as satisfactory as may be desired. In attempting to follow the process from water to vapour and vapour to cloud and cloud to rain, electricity and

temperature are stated to be the causes, which doubtless they are in *some way*; but *how* it is effected cannot be so easily explained. The general principle that solar-heat or air-heat causes water to become clear aqueous vapour, and cold air to convert it into cloud, and when the air is overcharged with aqueous vapour, to cause the cloud to descend in rain, converting by electrical action the minute vesicles of cloud into large drops,—all this is affirmed with confidence, and no doubt truly. But the *secret* power that effects these wondrous transformations cannot be understood, nor fully followed; notwithstanding the fact that, by a beautiful experiment, artificial clouds have been formed recently, in the lecture-room,* upon the principles we have remarked: but, having done it, the fact is elicited, but the mystery remains.

But the very motion of clouds,—so grand and majestic, so stately and graceful; vast mountains, moving on slowly, and changing their form, when not a breath of air is stirring, as though they were living things, possessed of a consciousness that enables them to find their own way and know whither they are going: this, too, is equally worthy of admiration; and we gaze with solemn awe on them, as though we beheld them moved by the very hand of their Almighty Maker. Something of this feeling may be experienced likewise on looking at the never-ceasing roll of the waves, as they tumble in upon the shore, and break upon the beach or rock in thunder, when the air is perfectly still. The strong

* At Professor Tyndall's Lectures, 1873, the formation of artificial clouds was demonstrated visibly.

impression produced on the mind by this well-known sight and sound is not weakened by the knowledge of the fact that it is caused by the tide; in other words, that the moon and the sun are the immediate impelling agents. The simple spectacle of a vast and invisible and inconceivable power in action, and causing movement, the source of which we cannot see, invests even this familiar sight with a feeling of awe and admiration. In it we behold the hand of the great First Cause,—the Law-maker of the world, in the exercise of His own natural laws; and we see Him, who is Himself invisible, as the real Mover of the *waves*, as well as Him who sits behind yonder *cloud*, who is the real Mover of *it*.

But what is a cloud, and how is it formed? Clouds, as we have already remarked, are but the aqueous or watery vapour with which our atmosphere is filled, but which is invisible until it undergoes that change which renders it at once visible, by conversion into a cloud or dark patch.

“Thus vapours turned to clouds obscure the sky,
And clouds dissolved the thirsty ground supply.”
ROSCOMMON.

The immediate cause of this strange transformation is generally attributed to the different temperatures of the air. Thus aqueous, or watery vapour, always forms one of the ingredients in our atmosphere; and though not chemically united to it, exists universally in it, being filtered, as it were, through the interstices of the ærial or atmospheric gases of which our atmosphere is composed. The air is thus always charged, more or less, with aqueous vapour in an invisible state; and the

supply of this vapour is constantly kept up by evaporation from the oceans and waters of the earth, which, by a slow and invisible process, are raised into the air from their surfaces by solar heat, or an increase of temperature in the incumbent air. The air, however, is only capable of containing a certain quantity of this invisible aqueous vapour, and when it is overcharged by rapid and extensive evaporation, and reaches what is called the point of saturation, or the air becomes saturated with aqueous vapour, then it is said the process of cloud-forming begins; and a sudden fall of temperature will convert it into a cloud, which may either remain suspended in the air, or under certain influences not altogether fully understood, descend in rain. This explanation, which is generally accepted as the truth, and probably is so, is, however, liable to exceptions, and is therefore not the whole truth, for it has been known that clouds often make their appearance before the point of saturation has been attained; nor does a fall of temperature necessarily produce clouds, as frequently clouds themselves are found to be warmer than the surrounding air; and if their formation were *solely* due to the coldness of the atmosphere, then the night would always be attended with clouds or fog, which is not the case, the night being often the clearest portion of the twenty-four hours, and, from the absence of the sun, should be the coldest.

Again: if clouds are formed solely by a high temperature, causing vapour to ascend from oceans and lakes and rivers, then clouds would invariably be found in warm weather; yet, practically, such is not the case, and an extremely high temperature often prevails, and

is continued for a long time without the appearance of a cloud. Thus it is stated that in January, 1785, the mean temperature in some parts of England was $66\frac{1}{2}^{\circ}$, a temperature which must have conduced to extensive evaporation under ordinary circumstances; but not a drop of rain fell, and the moisture of the air diminished so rapidly that it at last almost disappeared. Thus neither cold nor heat, evaporation nor condensation, in *themselves alone*, are capable of producing from the invisible air the thing called a visible cloud. The fact is, the process of evaporation and of cloud-making or forming cannot be traced by the human eye; nor is it fully made known to the human mind, although we can see the actual product and result of it enacted before our very eyes by the morning and evening mists that rise from our fields and gardens and meadows, and hang over rivers and lakes, and lie sleeping in the valleys, or appear in the dewdrops that bespangle the grass, or the rain and snow and hail that come down from heaven. The process of evaporation itself, by which this is effected, cannot be followed, and the metamorphosis of the waters of the earth into an invisible vapour, to be followed again by a visible vapourous cloud, is continually going on, while no sign of the process appears, and the air is all the while perfectly pure and transparent. Generally, however, and fortunately for us, the formation of clouds takes place in the higher regions of the atmosphere, where they may be seen on a grand scale, in such number and extent and density that were the same process to go on near the surface of the earth, on such a scale, it would render it a most uncomfortable habitation for us. To say the least, we should be per-

petually under a cloud,—baptized in it like Moses and the children of Israel: we should be true Children of the Mist, as the wild Highlanders, whom Sir Walter Scott describes in the “Legend of Montrose,” who inhabited the misty heights of the Scottish mountains. But this is not the case, because a wise and beautiful arrangement prevents it,—unless as an occasional exception, such as a London fog, or our inhabiting the regions of moor and forest and mountain and lake, which we have mentioned, where the very causes that free us from such troublesome mists constantly exist,—owing to the height above the sea level, and the vast extent of undrained land, of bog and lake and wet heather, and cold and rocky mountains, against whose barren sides the evaporated water drives, and clings there and floats, now in a misty white curtain, now descending to enwrap the steaming land or water beneath them in thick fog. The same thing goes on in the low marshy grounds; and the undrained fens of Lincolnshire once had a perpetual fog hanging over them, but now draining and cultivation have diminished or entirely removed them.

But there is a protective provision made, by which such exhalation from our fields and lakes and rivers below, even when visible in the morning or evening on the surface of the ground, as the day advances and the sun gains power, rises into the higher regions of the air, if not dissolved before it attains them; and if it does reappear it will be as a cloud of heaven, and not of the earth. Sir John Herschel thus accounts for this. He says when a body of vapour is generated from any warm evaporating surface, it ascends by its relative levity, losing sensible heat as well by its own expansion as by

its bodily transfer into and intermixture with colder air. Thus a provision is made by the very process of evaporation, that mists and fogs and clouds, if they are formed on the surface of the earth or water, or close to it, shall not remain in that condition long; but shall ascend, and leave us to breathe freely.

But what happens to the rising mist or fog after it has left the earth? Generally it rises slowly, like a beautiful white curtain, and disappears like a scene in a dissolving view. The disappearance, however, is only to the eye, as the cloud is still there, only in a different condition, being diffused through the air in the form of invisible vapour, which it contributes to fill till the air reaches the point of saturation, when it again becomes a cloud, either of mist or rain, in the higher regions of the air. Thus a perpetual wheel or circle of nature is kept revolving between earth and the heavens, by which the former is refreshed, while man is not incommoded.

The power or capacity of the air to contain aqueous vapour is an important item or condition in the history of cloud-forming. That capacity is found to depend upon temperature, and is variable in extent at the same temperature. The lower the temperature, the greater will be the condensation of the air and the compression of its particles, so that only a certain amount of invisible vapour can enter; but the higher the temperature, the greater the expansion of the air, and its consequent capacity to receive and contain the aqueous vapour. Most careful calculations have already been made in reference to this matter, as to what amount of water a cubic mass of air of certain dimensions can contain at 68° Fahrenheit; and the result of various experiments gave the annual

amount of evaporation in the City of London and its neighbourhood as 23,974 inches; while the annual evaporation of the whole surface of Great Britain is supposed to be equal to 32 inches of water, which would be equivalent to no less than the enormous quantity of 141,132,558,752 tons of water ascending in vapour from the surface of the country.

The mighty power of such an agency as this, which by a noiseless and invisible and all but insensible process transfers from the surface of the earth's oceans another floating ocean overhead, to be utilized according to the earth's requirements, is a truly wonderful feat of God's power, the idea of which should strike the most thoughtless with admiration. How truly does the Psalmist describe it when he says, "He calleth for the waters of the sea, and poureth them out upon the face of the earth."

This wonderful distillation and evaporation,—the transformation from the visible to the invisible, and back again to the visible and grand forms of cloud-ships, that (like a fleet of merchant vessels with all their sails set) move slowly onward through the deep blue ocean above, till having deposited their precious rainy stores with us in showers of blessing, they disappear for a while, to return again with a fresh cargo to replenish the still thirsty earth, and leave fruitfulness and plenty behind them. Who can look at all this,—at the wonderful accuracy with which they perform their appointed task, and not be sensible of the absurdity of the doctrine that says, "These have no master"? that does not recognise in the movement of every floating vapour, from the purest filmy gauze-like thing that hangs round

the cliff to the darkest thunder-cloud that frowns upon us, the hand of Him who sitteth behind the cloud and commands them?—and that every fleeting vapour has its own special tasks to perform, as well as every wheel and cog and bolt in the most solid iron steam-engine?

“Of all parts of the physical machinery, of all the contrivances in the mechanism of the universe” (says Lieutenant Maury), “the atmosphere, with its offices and adaptations, appear to me to be the most wonderful, sublime, and beautiful.” In the exquisite adjustment of that machinery, the clouds have other offices to perform besides those of merely dispensing showers of producing rains, and of weaving mantlets of snow for the protection of our fields in winter, important as are these offices. The philosophical mariner, as he changes his sky, is reminded that the clouds have commandments to fulfil, which, though less obvious, are not therefore less benign in their influences, or less worthy of notice. Among these we may notice them at work in moderating the extremes of heat and cold, and mitigating climates. The atmosphere with its clouds is the great regulator of the temperature of our planet. When spread out, as we so frequently see the latter, covering the earth as with a mantle, they prevent the radiation of heat from the surface of the earth, and keep it warm. Were it not for their intervention, we should be subjected, as the moon is, to the most violent extremes of cold and heat. Our Alpine summits are an instance of this; where, above the usual cloud-region, the atmosphere is so rarified as to have lost its cloud-forming power, and the too rapid radiation of heat, in consequence, leaves an ice-bound surface, with the sun shining upon it without the power to melt it, and

a freezing temperature; while, on the other hand, in those parts of the earth (in the lowlands) where clouds are few and rare,—such as the great sandy plains of Africa and India, where there is nothing to interpose between the scorching sun and the glaring surface of sand, but the transparent atmosphere well-nigh drained of all its watery ingredients and unable to form a cloud-screen,—there we have another proof of the great purposes which clouds perform in the economy of nature, and on the inhabited regions of the earth; where, like a great garment, they overshadow land and sea, protecting as they are formed the tender plant from the heat and the land from the drought and man from the burning rays of the sun; while in the case of the sea it restrains and modifies the intense power of evaporation from its waters. In thus regulating the temperature of our planet, therefore, we perceive the clouds to be our best friends and servants.

But there is another feature belonging to them, without which their services, valuable as they are to us, would be comparatively of little use: that is, their motion, by which they distribute and disperse their benefits over the globe. Of all the contrivances connected with their mechanism this is the most necessary and beautiful: the constant sailing by of thousands or millions of clouds every day over our heads is one of the most beautiful sights in our world. But here, as in other departments of nature, beauty is not all that is designed, but utility is connected with it. Why do these great cloud-ships continue perpetually moving onward, —now slowly and majestically, now hurrying on more swiftly than any railway train, on the wings of a hurri-

cane? And how is it that they are always moving? The answer to the first question is simple and obvious, but not the less interesting on that account: viz., for the purpose of dispersing the benefits they have to give to the various inhabited parts of the globe where their services are required. Without this provision only certain parts of the earth would be watered. It would be like having stationary water-carts in different parts of London, without wheels or horses, and that could not be moved where they were wanted. Certain parts of the earth then would be blessed with plenty and corn, while others would be barren,—some places too much water and some too little. Hence, the agency of the winds presents itself as the great moving power; but, as we have reason to believe, not the sole agents. Were they, however, the sole moving power of these great celestial fountains, their distribution over the world would not be the less wonderful. If every cloud has received the command to move onward to a particular spot, then must the wind which moves it have received its orders likewise, and been directed in its course whither to blow, and where to stop or change the current that propels the cloud. And when the infinite complication of the laws by which these wind-currents and clouds thus moved by them are taken into consideration, together with the distinct design and purpose in sending them here and there as messengers to perform their parts, the marvellous nature of their mechanism is before us: each cloud, and the current of wind that moves it, knows how far to go, where to stop, and what to do; where to withhold, and where to discharge its watery contents. How well is this described by the Psalmist:

"He commandeth the clouds: snow and vapour, stormy wind fulfilling His word:" as punctually and effectually as servants employed by their master,—one to pump, and others to draw and distribute water.

But, as we have remarked, other causes are at work to move these great waterpots of heaven; and their own mysterious movements in their dispersion, gathering, and outspreading, in their risings and fallings, when the air is perfectly still, must be attributed to other causes than wind; among these doubtless electricity, which had a hand in their formation, is a powerful agent. What steam is to the ships of earth electricity often is to these ships of heaven. The mutual repulsion or attraction of the minute watery globules or spray of a cloud,* when charged with electricity of the same kind, doubtless causes the cloud to expand, or open out, or extend itself, or the reverse: *i.e.*, close in, and condense their movements; as also that special operation by which rain is produced, when thousands of these minute vesicular drops merge into one, and become rain-drops, is justly and fairly attributable, for the most part, to electrical action, although the exact mode in which it is effected is not yet thoroughly understood. There is, however, evidently a self-acting, or internal and proper motion, in every cloud, more or less, besides what the wind

* Saussure states that when passing over the Alps he saw a multitude of small globules, like soap bubbles, the component parts of a cloud, floating before him, generally about the size of a pea, and apparently covered with an inconceivably thin coating. These particles being charged with electricity of the same kind repel each other, and they are for the same reason prevented from taking a liquid shape and falling in rain.

effects, so that on looking at them attentively they really appear as if endued with life.*

Clouds are likewise subjected to another source of movement, by the alteration of temperature which is continually occurring in the atmosphere, and by which in their transformation from vapour to cloud and cloud to vapour again, they are alternately made to ascend or descend like balloons, or to move forward to a more rarified portion of the atmosphere. Thus often does the thunder-cloud, advancing slowly towards us, seem to be propelled (apparently against the wind), so as to induce us to think ourselves safe from its approach; but this is a deception, the current blowing from us towards it being but an indraft towards the higher temperature of the cloud, and the attraction caused by its electrical nature creating a partial or comparative vacuum.

This illustrates how clouds may be moved by electricity if within reach of the attractive centre, when they will be drawn into it, as a boat to a whirlpool, floating upon the indraft or ærial current; or at other times when two clouds are themselves respectively charged with electricity of the *same kind*,—i.e., both positive, or both negative,—they will then mutually repel each other and move away; while if charged with electricity of an

* The hypothesis generally adopted respecting the cause of the production of rain is that of Hutton: viz., that it is caused by the union of extensive strata of air of different temperatures. If we suppose two masses of air of unequal temperature, and consequently an unequal quantity of aqueous vapour, to meet, a mean temperature will be produced in both, which must be lower than the temperature of one of the masses; and if the quantity of aqueous vapour with which they are saturated be too great for the temperature now attained by the contact, then a portion of it must be perceptible in rain.

opposite kind,—i.e., one positive and the other negative,—they will mutually attract each other, and approach, when a thunder-storm or discharge of their mutual electricity will take place. So in the ascent or descent of clouds, their movements are quite independent of wind as an agent; but the temperature of the air, and the electricity in it, are the movers. The rising of clouds in the air, on which a good deal of obscurity rested and still remains, is thus accounted for by Sir John Herschel:—

“Clouds,” he says, “when formed on the earth will ascend, on the principle of the comparative or relative levity of the specific gravity of the minute globules of water of which they are composed. When the sun shines on a cloud or mist over the earth, it becomes partially dissolved into vapour, which therefore ascends, and acts on the undissolved portion of the cloud, which will remain in a state of suspension, on the same principle that fine powder will remain suspended in a fluid of different specific gravity. When a body of *vapour* (says Herschel) is generated from any warm evaporating surface, it ascends by its relative levity, losing sensible heat, as well by its own expansion as by its transfer into and mixture with colder air.* The expansion will be greater in proportion to the warmth of the air through which it expands itself, and less when the

* The same principle is illustrated in the case of hot water, in the familiar instance of cooling tea by pouring it from the cup into the saucer. By expansion over the surface of the latter it is rapidly cooled, and still more rapidly if a little cold water is added to it. Thus the warm vapour expands itself, and is cooled not only by self-expansion, but by a colder atmosphere.

air is colder, and consequently denser, and less penetrable by the vapour. That the mere self-expansion of the ascending air is sufficient to cause precipitation of some of its vapour when abundant (he continues), is matter of ocular demonstration in that very striking phenomenon, so common at the Cape of Good Hope, when the south



Table-cloth Cloud, Cape Town.

or south-westerly wind that sweeps over the Southern Ocean, impinging on the long range of rocks that terminate in the Table Mountain, is thrown off by them, makes a clean sweep over the flat table-land which forms the summit of that mountain (about 3,800 feet high), and thence plunges down with the violence of a cataract, clinging close to the mural precipices that form

a kind of background to Cape Town, which it fills with dust and uproar. A perfectly cloudless sky meantime prevails over the town, the sea, and the level country; but the mountain is covered with a dense white cloud, reaching to no great height above the summit, and quite level, which, though evidently swept along by the wind, and hurried furiously over the edge of the precipice, dissolves and completely disappears on a definite level, suggesting the idea whence it derives its name,—the 'Table-cloth.' Occasionally, when the wind is very violent, a ripple is formed in the ærial current, which by a sort of rebound in the hollow of the amphitheatre in which Cape Town stands, is again thrown up just over the edge of the sea, vertically over the jetty,—where we have stood for hours watching a small white patch of cloud in the zenith, a few acres in extent, in violent internal agitation, from the hurricane of wind blowing through it, yet immovable, as if fixed by some spell,—the material ever changing, the form and aspect unvarying."

There could hardly, in this beautiful illustration, be a more satisfactory confirmation, not only of the important theory adduced by Herschel, but of the great fact already referred to,—that the differences of the temperature of the air are the chief and powerful agents in the formation or dispersion of clouds. The transformation of invisible aqueous vapours in a moment (as it strikes the mountain summit) to a visible form, and in another moment back to its former condition, while the definite form of the cloud remains, though not the same cloud for a moment, is the most ample proof that could be desired that the great Enchanter, who in an instant renders material

objects visible or invisible at pleasure, is not the wind (which only acts as the feeder for its power to work on, as it bears the aqueous vapour along), but *temperature*,—the otherwise invisible boundaries of which are thus clearly defined by the *cloud itself*.

The manner in which a cloud is thus formed or dissipated by temperature, is thus accounted for by Sir Humphrey Davy, in the instance of the cloud called stratus, or those low-lying mists that hang upon lakes, and rivers and meadows in the morning and evening, when the process may be perceived in operation.

"All persons," he says, "who have been accustomed to the observation of nature, must have frequently witnessed the formation of mists over the bed of rivers and vallies, in calm and clear weather, after sunset and in the early morning; the boundary of the mist in such cases being limited or confined to the banks of the lake or river, however winding, without extending beyond it. The cause of this is as follows:—As soon as the sun has disappeared from any part of the globe, the surface begins to lose heat by radiation, and in greater proportion as the sky is clearer: but the land and water, or moist places, are cooled by this operation in a very different manner,—the cooling on land being much more rapid than on water; when the upper stratum of which latter has cooled to 40° Fahrenheit either by radiation or evaporation, it sinks in the mass of fluid, and its place is supplied by water from below; and until the temperature of the whole mass is thus gradually reduced to 40° Fahrenheit or below it, the surface cannot be the coolest part. It follows, therefore, that whenever water exists in a considerable mass, and has a temperature

nearly equal to that of the land, or only a few degrees below it, and above 40° Fahrenheit at sunset, its surface during the night, in calm and clear weather, will be warmer than that of the contiguous land, and the air above the land will be necessarily colder than that above the water; and when they both contain their due proportion of aqueous vapour, and the situation of the ground is such as to permit the cold air from the land to mix with the warmer air above the water, a cloud of mist or fog will be the result. The formation of mists or clouds over water is thus accounted for by the *difference in the rate of cooling* (in the absence of the sun) *in fluid and solid bodies*. Thus relative temperature seems to be the chief agent in the formation of clouds on the earth's surface; the same principle being applicable in the case of damp and moist meadow-land, and marsh, and even ploughed fields, as in lakes and rivers; as such places contain a much greater amount of moisture (in an invisible state and at a higher temperature) than the adjoining land; and is converted into an invisible cloud of mist by the same cause,—the mixture of the cold with the warmer air."

Thus clouds are visibly formed on the earth; and doubtless the same process of cloud-forming goes on in the higher regions of the air on a far grander scale: for, notwithstanding the frequent changes of temperature we experience, a mean of more even temperature is preserved on the earth's surface than is found in the regions above us; and less violent extremes, such as must take place in the formation of those vast mountain-clouds we see towering above us, but which (happily for us) are only occasional visitors upon the

earth, when they descend to us by their own weight, when the atmosphere is in a peculiar state, and unable to resist them or keep them suspended. But they are comparatively seldom found upon sea or land; or if they are (by the beautiful protective contrivance already referred to), they are not permitted to remain long. This contrivance (if such it may be called) either dissolves and melts away speedily even the densest cloud or fog (whether formed on the surface of the earth or a visitor from the heavens), or causes them to ascend again to where they came from.

In contemplating these wonderful movements and transformations from the invisible to the visible, and *vice versa*, in the rapid change from the clear transparent air through which we can see, to the dark or bright and apparently solid-looking cloud, or the gradual variety of the latter, one cannot but be struck with what we should call (humanly speaking) the ingenuity of the contrivance. The beauty of the mechanism for the accomplishment of a great design or purpose (familiar as we are with these cloud-forms, and simple as the process may appear), when we come to examine closely into the complexity of the problem they solve, we find is only to be equalled by the perfection with which it is accomplished. "Who can tell the balancings of the clouds?" (says Elihu); but who can number or account for the infinite and ever-varying currents and temperatures by which they are balanced, and that are constantly at work to make the clouds perform their task and do the work appointed for them? In the midst of conflicting winds and varied temperatures and apparent chaos of ever-changing objects, will be found upon the whole the

most perfect order and the complete fulfilment of this great design in the strange metamorphoses which we behold before our eyes every day. It should be remembered, too, that we are not looking at a mere optical illusion; but a real change from the invisible to the visible, and back again. It is a perfect realization (in one instance, at least) of what St. Paul says, —that "the things which are seen are not made of things that do appear" (Heb. xi. 3): *i.e.*, are made of things which are invisible; but which exist, nevertheless, though we cannot see them.

This is a truth which men are slow to accept in religious matters, but are compelled to do in others, such as this. Not being able to conceive the existence of a thing that is invisible, or to follow the process of its becoming visible or the reverse, when they come to speak of an invisible world, and of beings invisible to naked sight, such as angels and the spirits of dead persons, they reject the doctrine altogether.* In truth we walk by *sight* here for the most part, and few by *faith*; yet in this instance, in the explanation of the forming of clouds or their dissipation, we are compelled by science to adopt the latter. We must exercise faith in the existence of what we do not see, in order to explain what we do see. Well would it be for us all if we exercised such a faith in the things that refer to the unseen and spiritual world, to which we really belong after all; for our conversation (*i.e.*, citizenship) is in heaven. (Phil. iii. 20). "And we look," says Paul, "at the things that are *unseen* rather than the things that are seen; for the

* See Appendix to First Heaven. (1)

things that are seen are *only temporal*, but the things that are unseen are eternal." (2 Cor. iv. 13.)

The recognition of this great truth, thus beautifully symbolized for us in the cloud changes, is full of the deepest interest to the Christian philosopher. Thus, his own immortal spirit which animates his body, he knows, though invisible to himself and others while he lives in the flesh, really exists nevertheless; and when he dies, and is leaving his earthly house of clay for the home which is eternal prepared for him in the heavens,—though leaving it perhaps in the presence of many spectators, will be equally invisible. How hard it is to those who look on at such a scene as the departure of the soul of some beloved relative or friend from the body, to realize their continued existence, simply for this very reason—their invisibility. Were we to see them actually depart, there would be an end to all doubt; but as it is, how we sometimes long that we might see, at the moment of departure, the spirit of those we have loved in this life pass visibly from the body, and out of the room of death when the senseless clay is left,—upward. To see the passage of the loved spirit to its rest above,—possibly under the guidance of some bright angel or angels, as Lazarus was conducted to his rest,—and to form an idea, ever so faint, of the glorious shape they have assumed,—for shape and form they doubtless have; but, alas, that shape we cannot see here, though we shall see it hereafter. It is invisible. Our eyes are holden, as the eyes of the disciples of Jesus were until He made himself known to them, and again were holden when He vanished from their sight; and we can no more behold the spirits of our departed friends and relatives with our mortal

sight, than we can see the cloud that shall be, in the invisible vapour which is beside us and around us and in which it really is, though unseen by us until it is subjected to influences which bring it into view with definite form and proportion. One thing we are thus assured of by this beautiful cloud transformation and symbol,—that visibility is not a necessary condition of existence; that visibility or invisibility are but different conditions of being, and have no relation to the question of existence. And if the invisible things with which this world is really filled were revealed suddenly to our sight, we should probably experience something like what Elijah's servant felt, when, at the word of the Prophet, "he beheld the mountain filled with horses, and chariots of fire round about him." And what the Scriptures thus teach us, and the clouds symbolize for us, the greatest of English poets has done likewise, who says:—

"Nor think, though men were none,
That heaven would want spectators, God want praise;
Millions of spiritual creatures walk the earth
Unseen, both when we wake and when we sleep:
All these with ceaseless praise His works behold
Both day and night."

MILTON.

But there is a great and obvious purpose fulfilled in clouds as prognostics of the weather. As the changes in the face of man are intended to indicate the passions by which he is moved inwardly, so, in the blue face of heaven, there is a language of which the clouds are the interpreters; and even the most fleeting of all things, the morning cloud that passeth away, can read us a prophetic as well as a moral lesson.

The practical study of the clouds as indicators of the

weather has always been the habit of mankind. Sometimes too much so, it would seem, as Solomon intimates when he says, "He that regardeth the clouds shall not reap." (Eccles. xi. 4.) But our Lord Himself remarks upon the habit, in His day, of forecasting the weather by the clouds,—reproving the scribes and Pharisees around Him for not using the same sagacity of discernment in reference to the "signs of the times." (Luke xii. 54.)

But such experience is generally gathered from daily almost instinctive observation of the effects of certain states of the sky and atmosphere, without any scientific classification of the form of clouds. Such a classification, however, has been made, and with tolerable success, though it would be manifestly impossible to classify the almost infinite variety to be found among these Protean forms.

The recognition of these different kinds of clouds is not difficult, with a little practice, and will form an interesting occupation for those who take an interest in the wondrous work of God in cloud-land, and who are enabled after a little time to test the accuracy of the distinction by their effects.

The first-named cloud,—the *cirrus*, or *curl-cloud*, as it is called by Mr. Foster,—is to the eye a beautiful snowy, fibrous-looking, delicate cloud,* generally at a great elevation; in fact, the highest of all, although occasionally it descends near the earth when it is about to predict a storm, and is then denser than when it is at its usual height, and will be found to rise in a direction contrary to that in which the storm advances. It is a

* Vide Plate, Frontispiece.



VARIETY OF CLOUD FORMS.

- | | |
|------------------------------------|--------------------------------------|
| 1. Cirrus (Curl or Feather Cloud). | 3. Cirro Stratus, or Mackerel Cloud. |
| 2. Cirro-cumulus, or Summer Cloud. | 4. Cumulus, or Mountain Cloud. |

beautiful feathery object, presenting itself in varied forms,—now resembling an ostrich feather, now what are called mares' tails, in wisps curved and twisted as though blown round by wind, but more probably by the action of electricity, of which this form of cloud is supposed by many to be the conductor. It is termed the Proteus of the sky, from its continued changes; and yet the general appearance of it cannot be mistaken, as contrasted with other clouds, with which it is found associating, with very different appearance. Sometimes it assumes parallel lines or bars, which have been called for distinction the *linean cirri*; sometimes a thread-like filament, or *filiform cirri*; and sometimes it appears like a distended lock of hair; and again, it appears like a beautiful network, called the *reticular cirri*. They are, in fact, the cobwebs of the sky, their tender, white, delicate fibres being often extended between two dark masses, as if to connect them by an electrical current; but it would be vain to attempt to follow all the changes of form assumed by this beautiful cloud: those which are most conspicuous only have been given. They are almost always found in the highest region of the atmosphere; and when on the summit of the loftiest mountain, with other clouds beneath, may be seen far above. The appearance of this cloud generally indicates variable weather, with wind and rain; and the direction of the fibres to indicate the quarter from which the storm will blow. They are not always such evil prophets, though; while *horizontal* sheets of *cirri* generally are followed by wet weather, they are frequently found distributed over the sky in small groups in fine weather. The circumstances under which they have been formed must in all cases be considered in

cloud-signs of the weather, and modify the expected results.

The next form of cloud with which we are familiar, is the *cumulus*. This is emphatically the mountain cloud, resembling our mountain chains, or single mountains. It consists of a vast hemispherical mass of vapour, of a solid and very magnificent appearance; generally of a conical shape, but often rounded, as terrestrial mountains are, and rising, for 20,000 feet, from an apparent horizontal base, but somewhat irregular. Sometimes they are detached heaps; sometimes stretched together in vast irregular piles of mingled white and dark, backed by the brilliant blue. They are nearly motionless during the day, except slow changes of their own shape, but at sunset they invariably disappear, breaking up into fragments similar to those from which in the morning they had been collected. They present sometimes a most beautiful and brilliant appearance, their edges lined with silver, or their centre a deep copper mixed with black, while the white portion resembles a snow-covered mountain. They are evidently the repositories of electricity, the vast Leyden jars of the world, loaded with it, and dispersing it wherever they are found. They have been termed the day cloud, as the period between morning and evening generally terminates their existence.

These clouds (which inhabit the lower regions of the atmosphere) are considered to prognosticate the approach of fine weather. Nevertheless, there are exceptions to this, and the highly charged electric atmosphere which they produce often causes a different result. They are as frequently the prophets of rain, especially when they

present to the eye a fiery appearance, and in denser masses and in lower strata of the atmosphere than usual. In fine weather the cumulus has a dull, depressed, rounded surface, and increases or diminishes in size, while maintaining the same form or shape more or less lasting through the day.

This is the grandest form of cloud to be seen in the heavens; where they act not only as beautiful objects, but as a screen from the sun, while they are *reflectors* and *refractors* of his light. The vast prisms and mirrors of the world, often adorned by a vivid solar rainbow in their midst, while at other times it is "the cloud with silver lining" of which the poet speaks.

It is in these clouds that strange and various shapes may be seen; resembling, sometimes castles, towers, and mountains: now animals, such as dogs, horses, and swine; or trees and plants; giant forms of men; weird faces sometimes peer out and look down; now a ship sails by; and now a chariot passes; and now a lion walks the heavens. Well has the greatest Poet of nature described it.

"*Antony.* Sometime we see a cloud that's dragonish;
A vapour sometime like a bear or lion,
A towered citadel, a pendant rock,
A forkéd mountain, or blue promontory
With trees upon 't, that nod unto the world,
And mock our eyes with air: thou hast seen these signs?
They are black vespers' pageants.

Eros. Aye, my lord.

Antony. That which is now a horse, even with a thought
The rack dislimns, and makes it indistinct
As water is in water."

Thus does the great Emperor, in the above descrip-

tion, symbolize the vanishing of his own greatness, and the changeable nature of earthly glory.

"*Antony.* My good knave, Eros, now thy captain is even such a body : here I am Antony ; yet cannot hold this visible shape, my knave."

Antony and Cleopatra. Act iv., Scene xii.

And thus in this beautiful form of cloud may we see many an airy castle of our own vanish. In this cloud picture of terrestrial things we may learn the unsubstantial nature of earthly greatness, and the changing character of all earthly blessings and all earthly goodness.

The next division of clouds is *stratus*. This is more of a terrestrial cloud than a celestial, and includes those creeping mists that are seen to rise, especially in summer, from low fields and valleys and marshes.

"Ve mists and exhalations, that now rise
From hill or steaming lake, dusky or grey
Till the sun paints your fleecy skirts with gold
In honour of the world's great Author,—rise :
Whether to deck with clouds the unclouded sky,
Or wet the thirsty earth with falling snow,
Rising or falling, still advance His praise."

MILTON.

The meteorology of Milton with reference to this form of cloud is perfectly correct : its nature has already been referred to. We will only remark that as a weather-sign it is considered to indicate fair weather, and is almost always followed by a fine day. When seen rising at sunset, or vanishing under the morning rays of the sun, it is one of the most curious effects of clouds to see ; or when it lies low on the ground, which it frequently does, not more than four or five feet ; or when



VARIETY OF CLOUD FORMS.

1. Cumuli Stratus, or Electric Cloud. | 2. Nimbus, or Storm Cloud.
3. Stratus, or Low-lying Mists.

seen from a mountain height in early morning, it spreads itself over the low-lying meadow lands, concealing the village, enveloping all but the lofty tree-tops and the spire of the village church in one lake of snowy mist, until gradually as the sun gains power it begins to rise like a curtain, revealing the features of the landscape, and dissolves into invisible vapour, again to reappear in some higher stratum, or possibly to descend in a misty shower.

Lieutenant Maury says, "In the harbour of Callao, in Peru, which is filled with the cool waters of Humbolden current, I have seen the bay covered with a fog only a *few inches* high. I have seen fogs there so dense, and with outlines so sharp, as to conceal from view the row-boats approaching the ship's side. These fogs, especially early in the morning, will conceal from view not only the boat, but the persons of the crew, up to the neck, so as to leave nothing visible but two rows of trunkless heads nodding at the oars, apparently skimming through the air and dancing on the fog in a manner both magical and fantastic. At other times the cloud stratum is thicker and higher. Then may be seen three masts coming into port, with top gallant sails and royals set, but no ship: these sails, nicely trimmed and swelling to the breeze in the sky, skim along over the clouds, and seem like things in a fairy scene."

The *cirrus cumulus* is a modification of the *cirrus*, by which losing its filmy and fibrous appearance in larger masses of white cloud, and sometimes separated (a very frequent form of it) into numerous nubecules, or small white clouds of the *cumulus* shape, they disperse themselves over the sky on fine summer evenings. This

form of cloud is frequently seen in summer in the intervals between showers. The varying forms and changes of this cloud are peculiarly beautiful. It is usually the forerunner of fine weather, but not always; for when joined with the *cumulo stratus* it is a certain indication of coming storm.

The *cumulo stratus* is what is popularly termed "a mackerel sky," because one of its commonest forms resembles the markings of the fish referred to, or is strictly like a shoal of these fish. There is also another form of it, resembling the wave-marks on the sand. It is always situated in a lofty region, and presents a beautiful and striking appearance to the eye, as it is scattered broadcast over the blue ground on which it rests: and when it makes its appearance the weather is generally clear and fine; but, like many other objects attractive to the sight, it is the sure forerunner of wind and unsettled weather, and no sailor likes to see "a mackerel sky."

In the last of the great divisions of clouds are the *cirro cumulus* and the *nimbus*, both compound clouds, the former of united *cumuli*, and swelled into immense proportions, and has the appearance of great solidity. It sometimes assumes the form of a fungus, with a thick stem: it is an awful-looking cloud, of stupendous proportions, with but little motion, and looks mischievous,—as though if it were to discharge its contents it would do untold damage. But Mr. Howard, whose attention to such objects and experience of them is greater than most people, declares it not to be a rain-discharging cloud. Its shape is sometimes so strange as to mock the wildest imagination of a cloud. It is most frequently

seen in countries subject to sudden change and variable climate, such as Ireland.

The *nimbus* is the true electrical storm-cloud that brings all the electricity of the heavens to bear upon the earth. It is invariably the source of a thunder-storm, and is attended with heavy rain and wind, hail, thunder, and lightning: the most formidable of all the clouds in the heavens. Its appearance is easily recognised by its blackness,—sometimes contrasted finely by a rainbow in the midst of it. It frequently advances along the surface of the earth like a tall giant, dealing destruction wherever it comes. At other times it floats within a short distance from the earth, exchanging shots with its positive electricity with the negative on the terrestrial surface. As its advance and course can generally be perceived, it is sometimes quite possible to avoid it, either on land or sea; but cities and towns that have to encounter it do not desire to see its awful form.

I may here refer, in concluding the description of this cloud, to a curious and somewhat startling effect produced by it when mixed with the ordinary rain cloud, or *cumulo stratus*, which I have seen myself,—living, as I have done for many years, in mountain districts, where such phenomena occur. When the clouds are in a transition state from vapour to rain, and are only partially dissolved, while a fresh wind is blowing, these white masses of distinct floating vapour, not yet dissolved, are seen relieved against the darker part of the rain-cloud, and are swept by on the wind through the midst of it, maintaining for a time a definite shape and form, but gradually dissolving. These sometimes appear quite suddenly crossing the road, like tall ghostly forms arrayed in white, from ten

to twenty or thirty feet in height. They disappear after assuming sometimes the most grotesque shapes, in which it is not difficult for a lively imagination to see strange weird faces and long floating robes and wild extended arms, as portrayed in the accompanying plate, and as on the occasion depicted, appearing so suddenly as to



Ghost Clouds. (*Cumulo stratus*.)

frighten the horse. To these transition forms of cloud may be fairly given the name of *ghost clouds*. They are generally a sign of stormy and wet weather, whether, thus seen, or more slowly advancing (as they sometimes do) in a white troop, showing themselves *just above* the brow of the distant mountain, when wet weather may certainly be expected.

CHAPTER III.

MIRACULOUS CLOUDS.

WE now come to the consideration of those clouds to which the term *miraculous* may be applied, as referring to the special part they have performed in the various communications of the Almighty with His people Israel, and as related in the history of the Old and New Testaments. In applying the term *miraculous* to these clouds, it is not absolutely necessary to suppose that there was anything different then in their constitution, or the material of which they were composed, from the ordinary clouds of our terrestrial atmosphere; but that their varying appearances and movements were such as to separate them altogether from clouds formed by the ordinary laws of nature with which we are acquainted, and rendering it impossible to explain their agency in the history of Israel by any natural causes (as has been attempted) without doing violence to the entire narrative and the plain meaning of language. The inspired narrative plainly regards, and would have *us* regard, all the circumstances relating to these clouds as supernatural; and any efforts by so-called Rationalists to explain it otherwise has proved an utter failure.

The first mention of a miraculous cloud we find in Exodus xiii. 21, 22, when the Israelites had left Egypt. We are there told God gave them a pillar of a cloud to direct their march. It is thus described: "And the Lord went before them by day in a pillar of a cloud, to lead them the way; and by night in a pillar of fire, to give them light; to go by day and night: He took not away the pillar of a cloud by day, nor the pillar of fire by night, from before the people." Here Jehovah is represented as being "*in the pillar* of a cloud:" *i.e.*, *in* a cloud of a pillar shape. This cloud was therefore the symbol of God's presence,—"*the shekinah*," as it was termed,—which rested on the tabernacle in the wilderness: sometimes seen at the door, as in Num. xi. 16, 17—25; sometimes on the mercy-seat; and from the depths of which the voice of the Almighty was sometimes heard talking with Moses and Aaron. (Num. xi. 17.) A similar cloud, betokening the presence of Jehovah, was manifested in the Temple long afterwards, as Isaiah tells us, when "he saw in vision the glory of God; and the house was filled with *smoke* as a bright cloud." So also at the dedication of the Temple by Solomon: "When the priests were come out of the holy place, it came to pass that the cloud filled the house of the Lord, so that the priests could not stand to minister because of the cloud; for the glory of the Lord had filled the house of the Lord." This identification of the presence of God with a cloud is very remarkable; and is not confined to the *Old Testament*, but is found also in the New. When the Father testified of His Son to the disciples on the mount of transfiguration, a bright cloud overshadowed them, and

the voice came from the cloud. Our Lord Himself also frequently speaks of Himself as accompanied by, or connected with, clouds,—indicating the majesty of His presence, of which they were the sign or symbol, thus (Matt. xxvi. 64): "Hereafter shall ye see the Son of man sitting on the right hand of power, and coming in the *clouds of heaven*." Thus He actually left the earth at His ascension in a cloud, which received Him out of sight; and the angels who addressed the gazing, sorrowful disciples, comforted them by telling that the same Jesus whom they saw depart should in *like manner* (*i.e.*, in a cloud) come again.

It is plain therefore that the clouds of Scripture, which thus symbolize the presence and concealed partially the glory of God, were miraculous in their character and nature, and were not governed by the same laws which rule the ordinary clouds of earth or the heavens. In the case of the pillar of a cloud given to Israel, this is most conspicuous; for no visible angel, bearing a human form, could more perfectly perform the part allotted to him than did this cloud; no attendant could be more faithful or vigilant than the mass of vapour which was at once the guide and protector of Israel,—the general who was to give orders for the march or for a halt, to dismay its enemies and to protect its friends. This cloud attended the Israelites (says Jerome) from Succoth probably to the passage over Jordan. When first given it was commonly in front of the army; but at Pi-ha-hiroth, when the Egyptian army approached behind them, it placed itself between Israel and the Egyptians, so that the Egyptians could not come near Israel all night, thus (Ex. xiv. 19, 20):

"The angel of God, which went before the camp of Israel, removed and went behind them; and the pillar of the cloud went from before their face, and stood behind them." Here it may be observed that the angel and the cloud made the same motion, as it should seem, in company. Nothing could more distinctly mark the miraculous character of this cloud. In the morning it moved on over the sea after the Israelites, who had passed through it, which the Egyptians following it and essaying to do, were drowned. From that time this cloud attended the Israelites as a faithful friend and servant. It was clear and bright at night, to give them light,—gleaming forth with a lustre, it may be presumed, not less than moonlight; and in the day, dark and dense, both to shield them from the sun, and be a conspicuous object to the camp. Thus, by its motions, it gave the signal to Israel to encamp or to march. When the cloud stayed, the people stayed, till it rose again; then they broke up their camp, and followed it till it stopped. (Num. ix. 17—23.) Again: the Lord appeared at Sinai in the midst of a cloud. (Ex. xix. 9; Ex. xxxiv. 5.) And after Moses had built and consecrated the tabernacle, the cloud filled the court round it, so that neither Moses nor the priests could enter. (Ex. xi. 34, 35.)

When the cloud appeared on the tent in front of which the assemblies of Israel were held, it was believed (and with truth) that God was present. This was conveyed to them by its peculiar appearance or motion, which was a sign of Jehovah's presence. (Ex. xvi. 10; xxxiii. 9. Num. xi. 25.) From this cloud the voice of God was heard: and we are told that the angel des-

cended in the cloud, and from thence spoke to Moses without being seen by the people.

Thus we think abundant evidence is afforded of the fact of the existence of miraculous clouds in the history of the Jews. Of whatever this cloud was composed, it was for the time being the obedient servant of Jehovah, existing and operating not *indirectly* and in sub-servience to the ordinary laws which regulate the vapour-clouds of earth (yet one of which doubtless it was notwithstanding),—now filling the court of the tabernacle and the lungs of the people there; now rising or falling or floating onward before them, as an ordinary cloud might do; but *directly*, and showing a settled purpose and design in its every motion, as indicating the direct and miraculous agency of Him who was *in it*. How completely this annihilates the doctrine held by some who profess to be believers of the Scriptures,—that God never acts *directly* and exceptionally upon the material objects which He has created, and which He has placed only under invariable and general laws. True, as the *ordinary rule* it is so; but, nevertheless, it is evident He can, if He pleases, dispense with those laws in any particular instance, and does so; and acts *directly* and *immediately*, instead of through the longer and usual course. Absurd indeed is the doctrine held by some,—that the Almighty never *can* do this; and equally absurd and false, because contrary to the Scripture, the doctrine that He never *has*. Is anything too hard for God? We have here an instance to the contrary, in the immediate and punctual obedience of a mass of condensed vapour to the direct operation of the Most High upon it. No change of temperature created or maintained the form of this

cloud; no current of wind directed it from the front to the rear of Israel: it moved in subservience to His will alone who made it,—acting as though it were an intelligent being, and doing as no cloud before or since has ever done, or could do, without a similar *interference*, as we may call it, with the laws of nature.

Our Lord, who doubtless was the unseen Agent in this very cloud of the wilderness, demonstrated the same great truth in the miracles He wrought when disease and death were *His servants*, and fled from the body at His word; when the yielding waters of the lake became as solid ground under Him; or when bread and fish were multiplied in the hands of the disciples, or the mouths of the hungry multitude, by the same *direct* and immediate operation of the Almighty, without going through the processes which were necessary according to the ordinary laws of nature or art: viz., that no corn need be sown, or grown, or reaped, or ground, or baked; but should come at once at the word, fully prepared: and no fish should spring from spawn, and grow, and be caught, and dressed ready for use; but in a moment, in the twinkling of an eye, should *exist* in perfection. If the inspired Scriptures be not a fiction, then is the doctrine of the *necessity* for evolution in every case (now so much the fashion to believe) false. The Scriptures tell us man was not created by evolution and transmutation; but by the direct and immediate operation of God's hand,—having "formed him from the dust of the ground, and breathed into his nostrils the breath of life, man became a living soul." If this be the case, the words of John the Baptist to the proud Pharisee are literally as well as spiritually true: viz., "God could

of these stones raise up children unto Abraham." As easy this as to make a vapour do the business of at once a *servant*, a *guide* by day and a *light* by night, a *general*, and an *army of defence*, and the wisest and best of counsellors.

But the very circumstance, that the Creator of this world selected a cloud for His covering, and made it do His bidding, gives an additional interest to the subject of the cloud-world. Who can see those mysterious vapours sailing by from day to day, and hour to hour, without being reminded of Him of whose presence they are the symbols. True, *they* preserve their forms and do His bidding according to established laws; but though not miraculously or exceptionally, not the less *wonderfully* or less *perfectly*. In their very *aspect* is beauty and glory and majesty. Their stainless snowy purity, when we see it, may remind us of His purity and holiness, who (as St. John says) "sitteth Himself on a white cloud." Their darkness and thunder and lightning may teach us to dread the frown and tremble at the wrath of Him who sitteth on the throne,—the Almighty; while their sunny radiance and dazzling splendour, whether silver or gold-lined, or dressed in their many-coloured robes of light, may remind us of the smile of Him who has Himself adorned our world with them, and taught us to see in every passing vapour reflections of His glory and exhibitions of His majesty. What brightness and beauty do clouds lend to our mornings! what scenic pictures do they paint for us at our evening sunsets! Green, crimson, blue, and golden oceans, light up distant grey cloud-lands, as though heaven itself were opened to our view; and a landscape is unfolded,

glowing with the splendour of a thousand prisms and mirrors,—stretching away, as though it were another country we beheld, and we had been given a glimpse of the happy land we hope one day to reach. Surely there is nothing among all the beautiful sights which the world can show us, more transcendently lovely than this coloured cloud-land, so familiar to us all,—there is nothing seen on earth that enables us in imagination more perfectly to realize the glory of that place not seen as yet, which is prepared for God's chosen people. (John xiv. 2.)

But not only are clouds symbols of God's presence and glory and kingdom, but He has Himself selected them as the emblems or figures of His mercy. Thus Isaiah speaks: "Behold, I have blotted out thy transgressions as a cloud, and as a thick cloud thy sins," of all the images employed by the prophets (says one of the most charming and eloquent of writers*) to carry to the mind of man the nature of the pardon conferred upon us, the greatness and unapproachableness of our sins, the depths of God's mercy, and the completeness and perfection of our pardon, it is to be found in this beautiful passage:—"Numerous and dark indeed as the clouds that obscure the heavens are our sins." Who can count the clouds that chase each other across the winter sky? Then may we count our sins. (Ps. xl. 13.) Like clouds, *they* shut us out from the sunshine of God's favour: they hang, as it were, between us and the sun. Like clouds, too, they augur future storms and tempests; and if unremoved, are

* H. Blunt.

tokens of coming wrath. But who can remove or blot a cloud out of heaven? They hang high above our heads: and though it may seem the simplest thing in nature to dissipate them, all the united efforts of all the men that ever lived could not blot out one cloud from the heavens. So is it with our sins from the instant when they are committed. From the very moment that the cloud is formed it hangs out far beyond our reach. No mortal hand can ever touch that sin; no mortal power can avail to pardon it. We may indeed pardon the crime committed against ourselves, but we can never pardon the sin: the latter belongs to God alone to do. The smallest cloud that hangs between ourselves and our Maker is indissoluble by us: there is but one Being in the universe who has ever said, or can ever say, "I, even I, am He that blotteth out thy transgressions for mine own name sake, and will not remember thy sins."

But the image of a cloud dissolving under the beams of the sun, sets before us clearly and distinctly the completeness of our pardon. As completely as the solid-looking black mountain disappears under the warm beams of the sun, and is blotted out as though it never was,—so are our sins by the Sun of Righteousness. As clouds and fogs and mists are dissolved in nature, so are our sins in grace, and full and free pardon and forgiveness are at once and for ever our own.

It will be impossible, when once our sins are blotted out, to find them and bring them again to judgment,—as impossible as it would be to reconstruct the clouds, with all their varied shapes and hues and tints, which we looked upon last summer, and which never outlived

the day we gazed upon them. Never, then, let us cast a glance at that stupendous vault which the Almighty Maker of the universe has hung up above us and around us,—never, as we behold the clouds passing rapidly across it, think these are fit emblems of my many sins, without at the same time thinking if the clouds picture to me my sin, thank God, the blue vault of heaven, through which they sail, portrays His mercy,—even the mercy of Him who pardons them, as fully, freely, and completely, and with as little delay or difficulty, as He would blot a cloud from the face of the heavens.

CHAPTER IV.

THUNDER-STORMS.

"The God of glory thundereth."—PSALM XXIX. 3.
 "He maketh lightnings with the rain."—JER. X. 13.



THUNDER-STORM, as it is called, consists of a variety of material agencies set to work in our atmosphere. These, whether electrical or chemical, and we may add, terrestrial, aerial, or oceanic, are all combined to accomplish a particular object. It is not therefore to be viewed as the effect of a chance meeting of certain clouds in the heavens, but as a systematic and regular part of the great material agency of our world, by which the atmosphere that surrounds our globe is enabled to perform its functions. Indeed, a thunder-storm is quite as important a power in maintaining the equilibrium of the atmosphere, as the arch or cornerstone in a building is to sustain it. Constituted, therefore, as our world is, there must needs be thunder-storms: *i.e.*, a periodical gathering together or collecting of clouds containing electricity, and producing lightning and thunder, rain or hail, and frequently, though not invariably, wind,—the fury of such a phenomenon consisting more in the force and power of the rain-fall and the lightning-stroke than in wind, which is not the principal agent in it, but rather incidental to it.

The precise or entire part which a thunder-storm performs in the mechanism of the aerial heavens is somewhat obscure. Enough, however, can be gleaned from its general aspect, to render it not only an important subject to acquaint ourselves with, as regards its physical effects, but deeply interesting when contemplated in its moral and religious point of view, which every work of the Creator should be.

As a physical phenomenon of our globe, its first characteristic is that of a safety-valve, or escape from too great an accumulation of the electric matter which pervades our earth, air, and ocean, and with which the world is, as it were, continually overflowing. This electric matter seems to be the principal, if not the most powerful agent, not only in what is called a thunder-storm, but in the entire globe that we inhabit. Its mysterious and as yet unknown matter is given forth in large quantities alike from the earth and the heavens; the former being what is called *negative* electricity, and the latter *positive*. Now a thunder-storm is but the discharge of the constantly increasing quantity of electricity from heaven and earth at the same time, just as two hostile armies would expend their ammunition in firing at one another their terrestrial artillery. How electricity is generated and increases so wonderfully at particular seasons is somewhat obscure. A good deal of it has its origin in the sun, there is little doubt. It is thought, too, that the continued and sudden changes of temperature, produced by solar influence on the ever-varying properties and chemical nature of the substances of which our atmosphere is composed, tend to keep up a constant supply of this wonderful agent. Among the generating

causes of electricity, that of alternate condensation and evaporation,—the formation or dissipation of clouds by change of temperature,—has been said to be a fruitful source. But this has been questioned by many eminent men in the present day. Certain it is, however, that the greatest quantity of electricity has been present during these processes. It is proved, also, that clouds, especially the large, white, fleecy, motionless woolpacks with which we are so familiar, are filled with electricity, and are but so many wandering aerial or nebulous volcanoes, occasionally relieving themselves of their electrical burden by a thunder-storm, just as the terrestrial volcanoes relieve themselves from subterranean matter. They are, in fact, huge Leyden jars, filled with that destructive yet life-giving and necessary fluid. Indeed, as our readers are doubtless aware, the lightning flash has long been identified with the electric discharge from the battery of an electrical machine. Forked lightning can be exhibited in miniature from the Leyden vial, filled with that mysterious substance called, perhaps without sufficient reason, a fluid.

Franklin, indeed, and many other eminent men since, have conclusively settled that point. The fiery globe that rolls and hisses along the ground, or the broad blue glare of the sheet lightning, or the more dangerous forked zigzag flash that strikes the earth, shatters the steeples of our churches, burns and destroys our homes, rends asunder the strongest oak, or kills in a moment man and beast, is, after all, the same substance as we can obtain artificially within the space of a small glass jar, and can confine there, or set free at pleasure in any quantity, with a shock strong enough to kill an ox if

necessary, or so slight as not to injure an infant; and it is also the same substance that is now our obedient slave and messenger to engirdle the earth in a moment, and convey our messages of peace or war, love or hatred, politics or science, joy or sorrow, under the Atlantic depths, as well as over mountain and valley.

But though the nature of this mysterious agent is still unknown, the laws by which it is governed may in a great measure be ascertained from its first formation, or appearance, to its most minute or its grandest effects; from the lifting or melting of a needle or a mote, to the rending of a mountain or the destruction of a man-of-war. Its affinities or dislikes, what it follows and what it repels, are likewise known, as well as the prevailing temper or pursuit of a man is known; though the spectroscope, which has revealed the constituents of the meteor flying at sixty miles in a second, has done nothing as yet with the lightning, which still remains a mystery. One thing, however, we do know for certain, and it is this: that with our present atmosphere, we must have electricity somewhere on our globe, and constantly at work, although not necessarily a *thunder-storm* everywhere. Experience has proved that it is seldom found beyond seventy-three degrees of latitude; but exist *electricity* must, and find a way to discharge itself. Banished it can never be, without such an entire change of atmosphere and planet as would constitute what the Scriptures term a "new heaven and a new earth." It is possible, indeed, that were electricity generated in less quantity, or were it more generally diffused over the surface of the globe, it would not be so dangerous; or that, were the constituents and ingredients of our atmos-

phere different, we might have no electricity, which is quite a possible condition either for the earth or any other planet; but as we are at present, our skies must darken, clouds must gather, and the thunder-storm must be generated.

Thus we may perceive its necessity from its own physical nature; but we may still ask, Are there any other direct physical benefits produced by it besides that of maintaining the equilibrium of the atmosphere, and acting as a safety-valve for electricity? The value of this function, it is true, is great. Were it not for separate local discharges in different parts of the world, the accumulated electricity of a single year, or even of a month, might burst forth in one great storm and envelope our globe, rending the surface of the earth to pieces in a moment, and destroying every living thing. This we can well imagine from beholding the effects of a circumscribed storm such as we often witness. Although, however, this arrangement is evident and indicative of the wisdom which conducts such mighty operations, it may still be asked, Why have it at all? Why not dispense with electricity? or, if it must be, is there any other benefit conferred by it?

To the first question it may be replied, that its being here at all is sufficient evidence of its necessity. Though man may imagine it would be better to be without it, the Creator does not think so. This should be a sufficient reply to such a query. To tell the Maker of the universe how He ought to have made our planet,—how that we should be better without thunder and lightning, would indeed be a pitiable presumption.

To the other query, however, some answer may be

given. Some of the benefits are obvious and sensible, such as the production of copious rain in climates requiring it, but not having it in a chronic form, as in some other countries. Also, presuming on the necessity of this mighty agent of our globe, a local supply of electrical action and power is thus provided for the plants and animals of our globe, which we have every reason to believe could not exist without it. Then there is the delightful feeling of relief experienced after a thunder-storm, when the air feels light, and nature is refreshed after a long period of drought. The air then seems to have got a new lease of freshness and beauty. The very rain-drops that hang on leaf and flower add beauty and embellishment to the scene, and enhance our pleasurable sensations. That there are many other physical benefits conferred by these visitations, which we are not aware of, we may fairly conclude. It is far from probable that the benefits conferred by such an important and mighty agent are confined to those of which we are cognisant. We may well believe that He who, when He had created our world, pronounced everything He had made to be good, did not except the operation of this loud-speaking, and alarming, and mysterious, but on the whole beneficent agent.

But this is the bright side of the picture. Let us now turn to the darker side, and ask what is the likely amount of mischief a thunder-storm does. We may look at its glories or benefits with admiration; but in what light shall we regard its terrors, for terrors it certainly has. Although some few persons like to see a thunder-storm, the majority dislike it, are terrified by it; and even in the case of admirers a sense of danger is

always mixed with their admiration, which impairs more or less the excitement and pleasure of the scene; and that there is real danger more or less in every thunder-storm is demonstrated. The action of lightning is every year fatal to man and beast, as well as destructive to property.

A French writer, M. Boudin, says that from 1835 to 1852, 1308 persons were killed by lightning in France, without including those who had been struck and injured without being killed; the average annual number killed each year being 103. The most destructive storms were in June and August, but none in November or the three months following. In England alone the average annual number of deaths by lightning is stated to be 22; in the United States 21·83; and in Sweden 9·64. In Ireland thunder-storms are much less frequent or destructive.

The mortality among the lower animals from this cause appears to be more extensive, probably on account of their greater exposure and their being congregated together. M. Abuddie tells us of 2000 sheep being killed in Ethiopia by a single flash of lightning; and at Sarco, in the kingdom of Naples, 120 sheep were killed out of a flock of 140, the shepherd boy escaping, though a kid which he held in his arms was killed.

Some of the most disastrous effects of lightning have resulted from the explosions of magazines in great cities by its agency, and the partial destruction of these cities in consequence. Thus the city of Brescia was nearly destroyed in 1769, Malaga in 1780, Luxembourg in 1807, Navarin in 1829, Garcin, in Spain, in 1843.

In our Parliamentary Returns for 1854, the damage

done to shipping for a series of years by lightning is given. It includes one hundred and six ships of the line, seventy frigates, eighty sloops and brigs, two schooners, seven cutters, five sheer-hulks, five ships in ordinary, and five steamers, two of which were of iron. In these cases there were one hundred and eighty-five lower masts destroyed, one hundred and thirty-five of which belonged to line-of-battle ships; one hundred of these being completely ruined; one hundred and eighty topmasts, one hundred and fifty topgallant masts, together with large quantities of rigging, sails, and other stores. Some of these ships were set on fire by the lightning, others were struck in the hull and severely damaged, while one hundred seamen were killed, and two hundred and fifty severely hurt. These casualties occurred between 1790 and 1840, a period of fifty years.

This catalogue, which shows what lightning *can* do, certainly does not present it as a desirable companion of man; for we may fairly extend this list immensely beyond the comparatively small area here given.

But, though the lightning is the real destroyer here, we must not forget the thunder which accompanies it, and which is always *really* simultaneous with the flash, though it does not always seem so to us. It is to this part of the phenomenon especially that the religious and moral considerations arising from the subject relate.

What is thunder? What is it that produces that most awful of sounds?

Many people speak of thunder as if it were the cause of danger and the source of the storm. This it is not, any more than the roaring of the sea is the cause of the waves. It is the effect that follows the lightning flash,—

in itself perfectly harmless. It, of course, adds much to the terror produced by the storm. It should, however, be looked upon rather as the voice of a friend giving notice of danger as it approaches or recedes, as the sound is louder or fainter in proportion to the distance from us. Many theories have been suggested at different times as to the cause of thunder, which is even yet the subject of conjecture. The most probable explanation is, that the lightning by its heat creates a vacuum in the air, which, rushing together after it has passed, produces the crashing or rolling sound with which we are familiar, the analogous cause and effect being seen and heard by the discharge of a gun. This is probably correct, though some difficulty has been found in accounting for the prolonged roll of thunder. Some have ascribed this to the reverberation of sound from mountains and valleys, or buildings, or clouds above, when heard from the ocean. This explanation, however, is not confirmed by experience. It is undoubtedly true that the sound of thunder is greatly prolonged by such causes in particular localities where its echoes may be naturally looked for; yet in localities where no such reverberation may be expected the same prolonged and successive peals or explosions may be heard; and indeed every variety which could possibly occur has been heard in the same locality, from the short, sharp, echoless burst, to the long-continued roar or successive rolls. Now, this could not be if echo alone were the cause of it. The conclusion arrived at by Hooke, therefore, in 1705, has been adhered to in preference to any new theory. This theory was that when lightning is multiple, as is seen in a long zig-zag flash, it has several separate points of

explosion in its course. And this is still considered the best solution.*

Should its course be that of an arc (as it is frequently) in the centre of which the hearer is, then the crash of these distant points will be simultaneous, or like one cannon shot; for they will reach the ear from the same distance, those distances being represented by the radii of a circle of which the hearer is at the centre. It is

* It is of some importance, especially for the sake of nervous people, that the distance and consequent danger of lightning can be ascertained without difficulty,—that distance being discovered by the simple calculation of the time that elapses between the flash of lightning and the report of the thunder. This interval, counted by seconds, which any person accustomed to the tick of a clock can do, gives the distance accurately, and for this reason,—light is so swift as to be instantaneous, but sound is a slower traveller, and takes a second to travel 1,142 feet; this number, therefore, multiplied by the number of seconds elapsing between the flash and report, will give the distance in feet, reducible to miles. Thus, if from the moment of seeing a flash you count five pulsations or seconds, the distance of the thunder-cloud from you will then be 1,142 feet, multiplied by five, equal to more than 5,710 feet, which is a statute mile, at which distance there is no danger to be apprehended. But if the thunder is heard one second after the flash, then the lightning is only 380 yards from you, and you are within the sphere of danger, and should take what precautions you can.

Franklin enumerates the common precautions for safety which everyone should adopt in a thunder-storm when possible, but which few seem to know or practice, judging from the annual records of death by such occurrences. They are as follows:—

- (1) Do not stand under a tree in a thunder-storm.
- (2) Do not stay abroad under it, if possible, but keep under cover.
- (3) Avoid contact with metal, gilt objects, the fireplaces or chimney of a room. The middle of the room is the safest place. To remain in bed is not certainly a safe place, though said to be so, unless the bed is in the middle of the room; and though iron bedsteads, so much now the fashion, are said to be safer than wooden ones, as being better conductors, it may well be questioned if they are safe, as the lightning will be thus brought into unpleasant proximity to the sleeper, and were the discharge heavy, might include the person in it in its deadly stroke.

The writer has thought it right in a popular treatise on lightning to insert the above, although doubtless well known to many.

otherwise, however, if the course of the lightning be extended in a straight line from the observer. The points of explosion would then be situated at different distances from the observer, who is situated at the extremity of the line, and consequently, though really simultaneous, each explosion would reach the ear at different times proportioned to the distance.

But what of the moral and religious aspect of this most awful of sounds accompanying this most terrible of phenomena? We are taught, as we have shown, to look upon it as a friendly monitor, which says, "Danger is near: look out!"

Is there, then, no moral or beneficent effect intended by the Creator in thus joining thunder and lightning as all but inseparable companions? He might, it is evident, have made lightning without the thunder,—indeed, there is such a thing as thunderless lightning, and it is very remarkable that such lightning is harmless when it occurs; but when danger is abroad, and when the lightning darts its dangerous fork to the earth, then comes the solemn peal of thunder, crying to man, "Beware!" I cannot but think there is design here. The silent flash might come and do its mischief unregarded, but no dangerous lightning can come without due warning,*—a warning nearly as expressive as that given by Moses from God to Israel in Egypt (Exod. ix), when he said (after predicting the plague of hail, and, as

* It might be said that the warning comes too late, as it does not precede but follow the lightning. This is true as regards the first flash and peal; but the first clap of thunder may surely be looked upon as a warning for what is to follow; besides several peals of thunder are usually heard before the storm approaches near enough to us to be dangerous.

it would appear by the 28th verse, a hail that was accompanied by "mighty thunderings"), "Send and gather thy cattle, and all that thou hast in the field; for upon every man and beast which shall be found in the field, and shall not be brought home, the hail shall come down upon them, and they shall die." And it is added accordingly, "He that feared the word of the Lord among the servants of Pharaoh made his servants and his cattle flee into the houses; and he that regarded not the word of the Lord left his servants and his cattle in the field;" and with such consequences to each as might naturally be expected. Those who took the precautions were not injured; those who did not were destroyed.

Now, it is remarkable that Pharaoh, when entreating Moses to withdraw this hail-storm, refers to the mighty thunderings which accompanied it, and which the margin of our Bible translates as "voices of God." Is thunder, then, one of the many voices of God? The Psalmist throughout the entire of the twenty-ninth Psalm calls it "the voice of God." Indeed, such it has ever been called, either figuratively or literally, by most nations of the world, who, feeling that it was a sound and indication of a Power that was Divine, have ever connected it with Deity. Thus the Greeks termed Jove, their sovereign Creator, "the Thunderer," as Homer calls him; and the ancient statues of the god place a thunderbolt in his hand. But the Scriptures, as we shall see in next paper, connect the phenomenon of thunder far more clearly with Divine institution, and as such it is intended to have a powerful moral and religious effect upon the minds of mankind.

Were it not so, indeed, we can easily understand that

it might be dispensed with. We have no difficulty in conceiving a world without it or its companion,—the lightning. There are, in fact, as we have already mentioned, parts of our globe where thunder-storms are unknown. From the meteorological observations of Captain Scoresby and Captains Phipps, Parry, and Ross, it appears that neither thunder nor lightning are known to take place beyond the seventy-fifth degree of north latitude. Even so low as the seventieth degree these phenomena are very rare. Thus it appears that the world could be so arranged as to be freed from it altogether, and it would seem that the maintenance of a cloudless sky is all that would be necessary for that purpose;* for, although the Latin poet does say—

"Dum Jove, sereno tonat æthere polo,"

yet it is very improbable that what he heard was thunder, being more likely, in the volcanic land in which he lived, to be a subterranean sound which has been frequently taken for thunder. In fact there is no instance known of thunder and lightning in a cloudless sky. Aurora flashes have been seen, and what is called summer lightning, in a cloudless atmosphere. But the former is not lightning, and the latter is only reflected lightning from a storm below the horizon. If, therefore, the atmosphere of our planet were so arranged that the electrical agency were diminished or more widely diffused, and such an equality of

* M. Quetelet, in his work "*Sur la Physique du Globe*," remarks that were it not for the existence of other bodies in celestial space, the terrestrial atmosphere would scarcely experience any electrical changes, and says that the sun must be regarded as the chief existing and disturbing cause.

temperature maintained as would prevent the rapid condensation or evaporation of clouds, our globe would never have a thunder-storm. It has been conjectured, indeed, by some theologians, that such was the original state of the earth, which once reposed in a long spring or summer untainted by a cloud, and that such a fate awaits us still in the day of millennial blessedness, when Christ shall return to the earth. It may be so; but such imaginations are unfounded in experience of the past,—though, of course nothing is impossible with God.

CHAPTER V.

THUNDER-STORMS—IN THEIR MORAL ASPECT.

"Storms are the triumph of His art."—G. HERBERT.

IT has been said by some writers and commentators, without, as I think, sufficient reason, that thunder-storms were the consequence of Adam's apostasy and the sin of our race, and were, in fact, unknown till after the fall. Others, again, say that it was a novelty introduced only after the flood, before which time the earth and atmosphere were unshaken by such dreadful phenomena. While there is not a particle of evidence for either of these views in the Scriptures, our knowledge of the past and present constituents of our globe and its atmosphere refutes such a doctrine. That thunder and lightning and rain are companions as old as Paradise, and even stretch far beyond that era, we have every reason to believe. Without rain vegetation would not have flourished even in Paradise; and when a rain-cloud is once formed, all the kindred phenomena belonging to it may be looked for. That there is heavy dew in the nearly rainless districts of the earth—so as in some degree to compensate for rain—is true; but to supersede rain altogether on the earth there is not enough; and electricity was evidently as much a necessary element in

the world when Adam was created as it is now. It is quite possible, therefore, that even in the peaceful bowers of Eden Adam and Eve may have trembled at the first thunder-storm, as they heard it rumble in the distance, and ran to take shelter from the pattering rain in the bower or cave which was their dwelling. But, looking back far beyond Adam's time, to the oldest silurian rocks,—and geology has photographed these for our inspection,—evidence is found of frequent heavy showers, with rain-drops so huge as powerfully to suggest the presence of their imperial cousin thunder and its accompaniments, then echoing through the vast solitudes of an untenanted world.

Be this as it may, however, the past and present condition of the globe during man's habitation of it show the continued existence and maintenance of this awful meteor as a physical fact; and not only this, but the Almighty has so connected Himself and the acts of His providence, as related in His Word, with "thunder's dread sound," that we are warranted in looking upon it not only as a *physical* power in His hands for executing the purposes of His providence, but as a great moral and religious power,—an instructor to the people of this world so long as the present dispensation shall last. If it were not so, why, may we ask, is it that the sound of thunder always reminds us of the Almighty? Did any one ever hear it without thinking of Him,—even the most thoughtless or stupid? I question if any one ever did. There is something in us that instinctively proclaims it to be "the voice of God," as it is called by the Psalmist, who devotes an entire Psalm (the 29th) to the consideration of it. There is no other sound like it;

neither the roaring of the sea nor the bellowing of the tempest in its wildest fury comes near to it; even the sound of artillery, which most resembles it, has not the same dread roll. There is something human and artificial in the loudest cannonade that man can create; but in the thunder there is a direct appeal to the super-human: *i.e.*, to the existence and agency of a power which, as it is greater than any human contrivance, so it produces a sound more appalling than anything that is connected with the ordinary sounds heard in our planet. That awful roar appeals to every sense, and says in language that cannot be mistaken, *It is God who speaks*: it is God that maketh the thunder, who is reminding us of His presence in His own world, where He is too often forgotten or ignored. He is breaking the ordinary silence of nature to speak to all of us. Hark!

Thus I cannot but think there is a general impression designed by God to be made by His celestial artillery whenever it is heard,—to make us feel that there is a God: that there is an unseen power above, and beyond, and around us, even in the midst of us, whether we like to acknowledge Him or not,—a power before which we are utterly helpless, and dependent, and passive; which we cannot resist, or control, or prevent, or escape from, but must humbly submit to.

The same feeling is produced, in another way, by pestilence, even in the minds of medical men. I have heard this feeling expressed by one of the most eminent and gifted men that ever adorned the noble profession of which he was the chief in this country. When moving about, as he did in 1831, in a crowded cholera hospital, among the dying and the dead, he said that

he felt how utterly powerless human aid and skill were to arrest the course of God's greater power. The moral effect in either case is immediate and powerful in its action on the human mind: we are brought, as it were, into the very presence of the Almighty, and feel our utter helplessness. The guilty have been known to tremble at the thunder peal,—

"Guilt hears appalled, with deeply troubled thought,
And yet not always on the guilty head descends the fated flash."
THOMPSON.

while even the Christian is humbled and deeply moved, though he knows it is the voice of a Friend to him.

It is nothing to say here, in the language of science, "This is only an instance of the operation of those regular and general laws by which the universe is governed, and which can be known and traced." The occurrence of thunder-storms, it should be remembered, is one of the most uncertain and apparently capricious of terrestrial phenomena, and not reducible to any regular law regarding its periodical visitation; yet granting that this general law has been ascertained, it must be borne in mind that the general laws of God in the universe have been established with a view to a particular application of their effects. It is in the case of thunder-storms, as in that of the other great agencies of our world, which though general are yet particular in their application,—such as stormy "winds and waves fulfilling His Word" on land and sea, and causing all the different effects which we know they can produce there,—shipwrecks and death. The truth is, that fire, water, air, and lightning, are but so many agents and messengers of the Most High to perform His pleasure and

accomplish His purposes, whether those purposes are great or small; whether to sink or disperse a fleet,* or to take away a single life. The Lord "has His way in the whirlwind and the storm," as well as in the lightning-flash, and neither can do anything without His control who made them. In truth all nature is full of God; and the poor untutored Indian is not in error in this respect when he sees Him in the cloud and hears Him in the wind,—in soft summer air, indeed, as well as in the wildest storm; the only difference being that man's attention is aroused by the former, while the latter escapes his notice.

But we are not left to mere conjecture in reference to the moral aspect of thunder-storms. The manner in which God identifies Himself with their phenomena, as related in the Scriptures, distinctly proves the Divine intention to produce by them such an effect upon the human mind as to lead men to recognise His presence and power in such phenomena.

Thus, the immediate and complete control of the Almighty over them is shown where the prophet Samuel is directed by God to call for thunder and rain, in order to impress the people with a holy fear of Him and the authority of His prophet. This being done by Samuel, he is immediately answered from the heavens; and it is

* A remarkable instance of providential interference in the dispersion of Admiral Hoche's fleet by a terrific storm in Bantry Bay, on December 22, 1796, when attempting to invade Ireland, will never be forgotten by the Protestant people of that country, who have ever regarded it as a most signal and striking instance of the providential agency and voice of the Almighty for the protection of His people, saying to them, as He did to the King of Israel of old, "This thing is from Me."

said, "The Lord sent thunder and lightning that day." Accordingly the effect produced is stated: viz., "All the people feared the Lord and Samuel." (1 Sam. xii. 17, 18.) They felt at once that it was God who answered them from "His secret place of thunder," and the moral effect was instantaneous as the lightning flash and its accompanying peal. True, this was an answer to prayer, and therefore it might be said by some to be a deviation from the general laws relating to such phenomena. There are no grounds whatever for such a supposition. The miracle consisted only in the adaptation of the general law to the particular case or occasion: it was ordinary lightning and thunder, but it was used as a moral instrument for accomplishing God's purpose towards His people at the time, assuring them of His presence and entire control over such phenomena at all times. So that in future they could never hear a thunder-storm without associating it with the Almighty, who thus proclaimed His sovereignty over it.

On another occasion we read of the destruction of the army of the Philistines by the same agency. When they attacked the people of Israel, while Samuel was engaged in offering burnt-offering, "the Lord thundered with a great thunder and discomfited them, and they were smitten before Israel." (1 Sam. vii. 10.) Here the same tremendous weapon was used by the Almighty without being asked for. It came as a timely succour to His people, preventing the possibility of their imputing it to natural causes only, or to chance, although it was but ordinary lightning and thunder; leading them, as in the other instance, to associate such occurrences with the direct agency of the Most High.

But what shall be said of the grandest display of all in which this meteor is exhibited in Scripture—at Mount Sinai; where the voice of God spoke the law in actual words of thunder, while the mountain burned and was enveloped in lightning, filling the people with such terror that they besought Moses (who himself, as the Apostle tells us, quaked or trembled with fear) that those words should not be repeated to them, and that they should have no more mighty thunderings and voices! The beautiful lines of the Poet well describe the scene as it is given in the Scriptures:—

"The Lord of might, on Sinai's brow
Gave forth His voice in thunder,
While Israel lay on earth below
Outstretched in fear and wonder.
Beneath His feet was pitchy night,
And at His left hand and His right
The rocks were rent asunder."

The Scriptural description is plainly that of a thunder-storm on the rocky summit of Mount Sinai, accompanied by a voice which spoke in accents of thunder, so as to be heard by the people six hundred feet or thereabout below.

"And all the people saw the thunderings, and the lightnings, and the noise of the trumpet, and the mountain smoking: and when the people saw it, they removed, and stood afar off. And they said unto Moses, Speak *thou* with us, and we will hear: but let not *God* speak unto us, lest we die." And then follows the moral effect, "Moses said unto the people, Fear not" (*i.e.*, with a slavish terror): "for God is come to prove you, and that His fear may be before your faces, that ye sin not."

In the recapitulation of this wonderful scene by Moses

in Deut. v. he says, referring to it after he himself had repeated the Ten Commandments to them: "These words the Lord spake unto all your assembly on the mount, out of the midst of the fire of the cloud, and of the thick darkness, with a great voice. And it came to pass, when ye heard the voice out of the midst of the darkness (for the mountain did burn with fire), that ye came near unto me, even all the heads of your tribes, and your elders; and ye said, Behold, the Lord our God hath showed us His glory and His greatness, and we have heard His voice out of the midst of the fire: we have seen this day that God doth talk with man, and He liveth. Now, therefore, why should we die? for this great fire will consume us: if we hear the voice of the Lord our God any more, then we shall die. For who is there of all flesh, that hath heard the voice of the living God speaking out of the midst of the fire, as we have, and lived?" Upon this entreaty it was that God consented to speak to them no more in accents of thunder, but hereafter through Moses. It was, indeed, the first instance, though not the last, where thunder and lightning were used, not only as accompaniments and symptoms of God's presence, but for the actual conveyance of words in human language,—words accented in thunder as a sanction to the law. The Apostle tells us that the law was given upon that occasion by the disposition or instrumentality of angels. This, doubtless, was the case, and so far, to the attendant storm on Mount Sinai angels may have been instrumental. It was miraculous in its character: but why did the Almighty thus invest Himself in this thunder-storm? for thunder-storm it was, and not a volcanic eruption, as the primitive rock of the Sinaitic range

proves. Why, but with the intention of producing a great moral impression upon the people, and teaching them, not only on that occasion but for the future, that they heard the voice of God not in distinct accents indeed, but as a general testimony to His power and presence in the world He has created.

In like manner did God break up and put an end to the bitter controversy between Job and his friends by a thunder-storm, out of which He spoke to them. It is evident this storm had been gradually gathering and approaching them while they conversed; so much so that the subject of thunder-storms and control over them was suggested, and became a chief topic in the address of Elihu just preceding, who most likely saw it approaching. Rain was probably the precursor of this storm. Accordingly Elihu says (Job xxxvi. 27), "He maketh small the drops of water: they pour down rain according to the vapour thereof." Here the darkness increases, and he continues (ver. 32): "With clouds He covereth the light; and commandeth it not to shine by the cloud that cometh betwixt." A peal of thunder is now heard, and he proceeds, "The noise thereof sheweth concerning it" (*i.e.* the cloud). Elihu is now awe-stricken, and exclaims (ch. xxxvii. 1), "At this my heart trembleth, and is moved out of his place." Another and louder peal is heard, and he calls Job's attention to it. "Hear attentively the noise of His voice, and the sound that goeth out of His mouth;" and now a universal burst of thunder takes place, and Elihu, in wonder and admiration, exclaims, "He directeth it under the whole heaven, and" (as flash succeeds flash) "His lightning unto the ends of the earth." The peals of thunder following the

lightning are remarked. "After it" (*i.e.* the lightning) "a voice roareth: He thundereth with the voice of his excellency; and He will not stay them" (*i.e.* the lightnings) "when His voice is heard" (*i.e.* the thunder peal is not the conclusion or end of the storm, though it follows the lightning).

The moral effect or conclusion produced on Elihu's mind is thus described: "Great things doeth He, which we cannot comprehend." "With God is terrible majesty. Touching the Almighty, we cannot find Him out: He is excellent in power, and in judgment, and in plenty of justice: He will not afflict. Men do therefore fear Him." Here the Almighty approaches, and speaks out of the thunder-storm and whirlwind accompanying it, and breaks up the conference in a voice of thunder, saying, "Who is this that darkeneth counsel by words without knowledge?" and in the magnificent address that follows, refers to the subject of the storm of which they had been witnesses. "Canst Thou send lightnings, that they may go and say, Here we are?" If ever there was an instance of the assertion of His immediate control and command over every flash of lightning or peal of thunder accompanying it in our heavens, it is here; and the sublime accompaniment of the storm to the Almighty's address while speaking, is sufficient evidence of the moral result intended to be produced, a result which Job himself immediately expresses in his never-to-be-forgotten words that follow the conclusion of it: "I have heard of Thee by the hearing of the ear, but now mine eye seeth Thee" (*i.e.* realises Thy presence); "wherefore I abhor myself, and repent in dust and ashes."

There is only one more instance in which God's presence is identified with the sound of thunder, and that is in the New Testament. In John xii. 29, in reply to the request of Jesus to His Father, "Father, glorify Thy name," a voice came from heaven which said, "I have both glorified it, and will glorify it again." This voice was spoken in accents of thunder. The people said it thundered; yet Christ Himself calls it only a voice. "This voice," He said, "came not because of Me, but for your sakes:" *i.e.* not to comfort Me, but to convince you that I am the Christ, the Eternal Son of God. That this was miraculous, there can be no question; but still the reply was given in thunder, as at Mount Sinai. The Jews held, indeed, that among the sundry and divers manners by which God spake to His people after the Prophets had ceased to speak, was what they called *Bathcol*, or "the daughter of a voice;" and that in thus revealing His mind to His people, God made use of an angel to do it. Hence the different expressions of opinion upon this occasion; some saying that it thundered, others that an angel spake to Him. Both, it is probable, were the truth. God the Father spake by the ministration of an angel, accompanied with thunder. The same intention or purpose appears here as was exhibited at Mount Sinai,—to awe the minds of the hearers, as well as to call their attention to what was said.

Enough, however, has been said to show that thunder and lightning are not only actually instruments of God's power and providence physically, but emblems or symbols of His majesty and accompaniments of His glory,—as St. John tells us in Revelation iv. 5, and viii. 5, when describing heaven itself. He says, "There were light-

nings, and thunderings, and voices, which proceeded from the throne of God."

Familiar, therefore, as we all are with a thunder-storm, let us not be content with viewing it merely in its physical or scientific aspect, but study to contemplate it from its moral and religious point of view, as specially connected with the presence and power and providence of Jehovah in our world.

Let us also see in it a picture of that law of God which, though beautiful, and grand, and holy, and just, and good in itself, is not only unable to save us, but is unsparing in the destruction of those who trust to it as a covenant. As well may they commit themselves bare-headed to the mercy of the thunder-tempest as trust to it for salvation. When thus used it can only condemn and destroy. The man who takes the law of Sinai for his hope and guide to heaven, is like the traveller who prefers the forked lightning for his guide by night instead of the soft and peaceful moonlight. By the works of the law shall no flesh be justified. The contrast between the covenants of Mount Sinai and Mount Zion have been well shown by St. Paul, in Hebrews xii. 18—24. The one is clothed in majesty, storm and darkness, danger and terror, insecurity and condemnation; the other in calm, and peace, and brightness, pardon, and safety. To this shelter the Psalmist, too, leads us in his inimitable picture of a thunder-storm in the twenty-ninth Psalm. After describing the thunder of the voice of God—as it is heard "on many waters,"—powerful—full of majesty—breaking the cedars of Lebanon—dividing the flames of fire—shaking the wilderness—making the hinds to calve—discovering the forests—

sitting upon the floods, David represents God to us as closing by the application of this power to the salvation of His people. The storm rolls away, and a still small voice is heard. "The Lord will give strength unto His people; the Lord will bless His people with peace."

CHAPTER VI.

THE INHABITANTS OF THE AIR.

"Who can recount what transmigrations *there*
 Are annual made? What nations come and go,
 And how the living clouds on clouds arise:
 Infinite wings—'till all the plume-dark air
 And rude resounding shore, are one wild cry."

THOMPSON.

LEAVING now the philosophical and chemical analysis of our atmosphere, let us turn our attention to it in another point of view,—namely, as a vast sphere or world filled with its own inhabitants. We know the air teems with inhabitants, no part of Creation indeed seeming to be destitute of them. Some of them are so small as to be invisible to the naked eye, yet all alike disport themselves in it, many live and die in it, and we have reason to think, derive the highest pleasure from it. Among the chief inhabitants (as we may call them) of the air must be classed *birds*,—at least they spend a greater portion of their active lives in it than on the earth; and, considering their size and importance, may fairly be considered as the principal inhabitants of the air. Being in it more or less from sunrise to sunset, they may be indeed compared to sailors who pass their lives chiefly at sea; or they may be considered as themselves ships of the air, continually passing and repassing the ethereal ocean above, their wings the sails and oars, their tail the rudder, their head and breast the prow. There are

above three thousand distinct species of these known, besides innumerable varieties of each species. What a vast crowd then have we here of ærial inhabitants, all made with one great design and therefore on the same model as to general shape and form, though differing immensely both in size and peculiarity of construction in other respects, but all intended to sail in the same great sea above, all adapted for rapid motion through it, and with wings to propel them! Birds are, in fact, the fish of the air, even as fish are the birds of the ocean; neither could change places with the other it is true, both being formed with a special reference to the element in which they are to move, but the analogy between them is perfect. The entire construction of the bird anatomically, indeed, proves this special design in their case the more closely it is examined; certain peculiarities of construction are perceptible, without which, even wings would be useless appendages: they might have them, indeed, but could not use them. Hence the possession of wings by man would be but a small instalment towards his flying; the entire arrangement and structure of his body must likewise be taken into account, and be altered in the same direction.

The bony frame of flying birds, for instance, is peculiarly light, when compared with their body, or that of any other animal, and the bones themselves are hollow. The muscles connected with the wings, for the purpose of beating the air downwards (which requires most power), are one-sixth part of the weight of the whole body; whereas, in man, the muscles are not one-hundredth part so large proportionally. Air-vessels in the interior enable birds to blow out the hollow parts

of their bodies, and inflate them when they wish to descend slowly, or to rise more swiftly, or float in the air. The shape of their body, too, is equally well adapted for flight: formed like the prow of a vessel in front, rising by a gradual swelling to its bulk, and falling off in an expanded tail to keep it buoyant, and at the same time act as a rudder in a fourfold capacity,—for rising and falling, as well as directing their course to either side. To this may be added, the direction or inclination of the feathers, and their over-lapping in the line receding from the head, or direction of the flight, which would otherwise be ruffled and torn from them by the resistance of the air. The peculiar shape of the wing, too, which is broad near the body, and narrow at the end, enables them to cleave the air rapidly, without too great a resistance at the extremity,—this and the construction of every separate feather, which unites strength and lightness in a manner that no human skill has ever succeeded in imitating, and marks out the bird as specially intended for the yielding element in which it is to display its activity, reveal the perfect skill and wisdom of its Creator in such a manner as to strike the most thoughtless who examines it.

Many of the tribe of birds, however, enjoy the pleasures of the other great element as well, and spend a great portion of their time on the water, or in diving beneath it. In this they resemble the flying fish, which occasionally dive upwards into a strange element. But even those birds called aquatic possess the power of flight likewise, so that the number of the winged creation that are shut out from the ærial world is very small, the greater part, indeed, enjoying the wide range

of air, and ocean and land, without any limit but climate. And even that is superseded in the case of migratory birds, which follow the climates of different countries in their flight with undeviating punctuality, as we ourselves do in pursuit of health or enjoyment.*

There is no part of Creation, indeed, where freedom and happiness would appear to be enjoyed so perfectly as in the world of air, no life so enviable, considered on the whole, as the life of a bird. The mere power to fly must be in itself a sensation of exquisite pleasure, conferring as it does, the power of rapid and unimpeded, and almost unlimited motion, on those creatures who possess it,—a sensation in which all animals (almost), including man, appear to delight. The life of a bird must be as a fairy tale which one has often dreamed of, but never realized, and awoke with a pang of disappointment, to find himself still bound to the solid earth. The entire freedom from restraint which is experienced in the flight of a pigeon or a swallow, together with the instantaneous exercise of mental volition and bodily freedom, or the power to go at a minute's notice whither you wish, even to the ends of the earth, must be something almost Divine in its enjoyment. That birds have volition and minds sufficient to direct them in their various flights, who can doubt that has observed their habits, notwithstanding the saying of a celebrated naturalist, "How can an animal have intelligence whose eye is half as big as its head?" But though the intelligence of birds may be of a lower order than some other animals, it is not so low as some have

* See Appendix to First Heaven. (2.)

imagined, while it is sufficient for their purpose. There must exist in their minds, at all events, the desire to transport themselves to any particular spot of earth they wish, with lightning speed. They cannot but experience, in doing so, an exulting sense of power and freedom, as they rise aloft to the clouds, to float there either calmly and silently or, like the lark, to pour forth their sense of it in a gush of song, while every beat of the flapping wing that cleaves the viewless, and to others, yielding element around, assures them of their entire control over it. They cannot but feel, too, as they look around, that *there* is an expanse of boundless freedom, a refreshing bath in which to plunge, and gambol, and sport,—now performing varied feats of skill, as swimmers do in the water,—now poising themselves above the clouds, motionless and still, and with outspread but slightly quivering pinion,—now diving suddenly through hundreds of fathoms of the liquid substance around them, appearing to drop like a stone till they are within a few feet of the earth, when the outspread wing again arrests their fall,—again to shoot upwards towards the heavens with a joyful burst of song. Who could believe that a lark does not enter into the spirit of all these feats, though in a much lower degree, as well as the silent intellectual watcher, man, far below who beholds them ; or that, though the lark may not derive *as much*, he does derive *an immense* amount of exquisite enjoyment from the powers he possesses ?

Look at that swallow, now darting like an arrow from a bow, or cleaving the air like a flash of lightning with its rapid wing ; or the hawk, or the albatross, sailing proudly down the wind, with every feather and pinion

spread like a ship in full sail at sea ; look at the vulture, or the monarch of all—the golden eagle,—soaring far above the clouds, in those solitary regions frequented alone by himself, where he floats on with the most perfect and king-like tranquility, the golden sun on which he gazes illumining his wings.

Meantime the smaller birds below have their own peculiar pleasures in this, to them, delightful element. Though their journeys are but comparatively limited, yet the same delightful feeling of the power of volition and motion pervade this species, whose more rapidly beating wings carry them not less speedily and safely, but to yonder leafy grove, or spreading branch where they have built their nest, or lofty tree-top where the thrush sits at morning and evening, and calls in thrilling tones to his mate, when both dart off together wildly as though animated by one spirit,—a spirit as buoyant as the air that supports them. Surely if ever there was a representation of the happy existence of a spiritual being, it is exemplified in the life of a bird. Those tenants of the ethereal world, in which they live and move continually,—whether we look at their brilliant eye, their graceful form, their glorious plumage, their fleet wing, their speedy flight heavenwards, or the pure region they inhabit,—remind us of those bright spirits of whom we read in Holy Writ, and whom we have every reason to believe men will one day resemble, when, with lighter bodies, we too may dart from one sphere to another with a speed to which the flight of the swiftest bird is but as the crawling of the snail.

But there is another class of the inhabitants of air, more strange and wonderful in form than these, whose

gauzy wings, and glowing colours, and humming flight, and almost infinite number, bewilder the mind that attempts to classify them or follow them in their aerial flights. I mean the vast winged insect creation, the lives of many of whom are purely ærial, mounting into it at their birth, and never leaving it till their death. The variety of form which these possess is indescribable. Among them it is true there are some which may be ranked among the torturers and blood-suckers of the animal races beneath; some also which carry a poisoned dagger ever ready to wound. These must be ranked among the rapacious birds of prey,—the evil angels of that pure region. Yet though there are some that have the form of the dragon, there are others with that of the angel; and when the structures of all are examined, their flight followed, and their habits ascertained, they present to the admiring lover of nature an equally perfect adaptation of the ærial world to their state of being; all of which rejoice alike in it, from the gay butterfly that spreads its scarlet wings in the sun, to the blue dragon-fly or sylphide that unfurls its gauzy pinions, or the little bee that, like a grain of dust in this great world, has been seen, as a great naturalist informs us, speeding by itself across the British Channel, and when far out of sight of land, directing its course to the shore, humming merrily as it flew.

Surely, then, the ærial world is not an untenanted one: is not an uninhabited desert, where no life is seen. If it supplies man with the breath that is in his nostrils, it does the same for ten thousand times ten thousand millions of other beings, and supplies them with sources of delight as well as life. It is no solitary ocean where

no ship may be seen passing. What shall we say of those myriads of migratory birds that, far above in the higher regions of the air, press forward in the shape of a V,—others differently arranged, but each having their leader in the van,—speeding onward over vast oceans and continents, keeping in those altitudes where clouds are piled in fleecy mountains, and from which they durst not descend for days, but are ever on the untiring wing? Thus these bird-ships are ever traversing the blue depths of our ærial sea, their sails are ever spread, and their paddles or oars are ever out; and, looking at it as the Great Creator did when He caused the birds to fly in the open firmament of heaven and pronounced it very good, it may truly be said that its pathless fields are as full of life and motion as the earth itself.

A few more great purposes or designs in this air-world now meet our view in conclusion: viz., our atmosphere, or first heaven, is specially designed for the conveyance of *light*, *heat*, and *sound*. Without air there could be no diffusion of light, and the silence of death would reign here, combined with the coldness of the Arctic regions,—such conditions, in fact, as are in all probability fulfilled in the case of our airless satellite, the moon. By the medium of the air the sunlight is scattered or diffused over the world, and not only in the one direction in which it comes; the landscape is softened, and the sudden appearance or departure of light melted into soft twilight, and adapted for the eye, which abhors sudden change, and thus a beauty is flung over the morning or evening landscape and scenes of earth which they would not otherwise possess: the blue hazy mountains, or the softened splendour of the sea, the strong foreground fading away

in the distance, would be things unknown to the human eye, and the painter's art and skill in imitating them would be unrecognised and unappreciated.

But this is not all: by this wondrous envelope not only is the sense of *sight* gratified, but our feeling,—in fact the comfort of our existence depends on it. Through the medium of the air alone it is that we obtain the warmth and heat that the sun gives out, and without it his rays might shine on us in vain; by its density near the earth it produces a heating or calorific effect, when the sun has warmed it, as though we were plunged in a warm bath. Were it reduced to the tenuity it possess at fifteen thousand feet above the earth or sea, we should find ourselves amidst Alpine glaciers and perpetual snow, not to speak of other inconvenient effects upon our breathing.

But this kind of covering regulates the temperature of our planet, as doubtless, similar ærial coverings do those of other worlds which we see,—now conveying a warmth which we could not receive without it, now tempering a heat under which we might expire but for the friendly protection of its clouds and mists. These latter, indeed, form one of the most extraordinary features of this ærial world, and bring it before us as a mighty forcing pump, continually drawing up the ocean waters to the heights above, to pour them down again in fertility and blessing on our heads, to supply our rivers, and fountains, and springs, and lakes with fresh water distilled above, instead of salt; and thus form a perpetual circle, an ebb and flow of watery tides between heaven and earth—"the waters above the firmament and those below it"—now condensed by electricty into those bright and fleecy

masses that float high above us, laden with thunder and lightning, rain and hail,—those vast woolpacks which are but electrical batteries whose fury we so often experience, now bursting in thunder, now distilling in soft showers and dropping in gentle rain upon the otherwise dry and parched regions below. How this is all effected is still a mystery; that it is in some way connected with electrical action we know, but beyond this we know but little.

But our ærial world has another quality, certainly not the least important of all we have already mentioned, and with this we shall conclude. I mean the power of conveying sound. What is sound? Sound is but the disturbance of the fluid called air, into waves or undulations proportioned to the violence, and extent, and intensity of the disturbance. One single word spoken in the air is like a stone cast into the water; the rippling waves of air laden with sound fly out on every side, and strike the tympanum, or nerve of the ear, conveying the particular vibrations that the word spoken causes, and thus speech reaches the brain and the mind. And so is it with every other sound in nature, from the thunder that rolls in the heavens, to the song of the thrush or the robin that sits on the spray; from the roaring of the tempest, to the soft accents of the human voice; from the pealing of an organ, to the humming of a bee,—all the sweetest music that ever floated on the wind owes to that wind itself that it has any voice or sound at all: were it not for it a death-like silence would prevail. But, through the agitation of this wonderful medium, the thoughts of men are conveyed to each other; through it the fountain of knowledge is unsealed, and gushes forth to the world; through this the harmonies

of heaven are maintained on earth, and the music of the spheres becomes a notable reality. What should we do without such an appendage to our globe? No speech, or voice, or language would be heard,—but utter silence; no soft music with its dying falls and plaintive strains of harmony, no child or friend's familiar accents and well-remembered tones living through the memory of a life, and enabling us to recognise them when, after long absence, their countenance and appearance have been so changed that our eyes are deceived, and we should never know them otherwise; but here the other sense comes to the rescue: there is a changeless spell about the sound of the voice which at once assures us of their identity, when all other traces of it are gone; it has lingered with us when they departed from us, and has returned to our memory now they have come back. And it is the atmosphere that has done it,—it is the ærial canopy over our head to which we are indebted for it. How gracious this provision then, how wonderful this first heaven,—the porch or portal to the second and third,—the first great ante-chamber to the palace of the King of kings; equally worthy of our contemplation by day or night,—when the sun lights it up with his glory, or the moon and stars look down on us through its dark blue depths; in calm or storm equally sublime; when enthroned as it is by the Creator Himself, who has His way in the whirlwind and the storm, and the clouds are the dust of His feet; or when calm and pure, the Christian gazes upward through its purple expanse, and seeks through its open door to pierce the heaven of heaven itself, and get a glimpse through the starry hosts far above, of his own distant and longed-for home.

APPENDIX (1).

WE may except here the superstitious *credulity* which peoples the world with ghosts, and the charlatanism that presumes to call up the spirits of the departed without any warrant for it. But faith in what is revealed must be distinguished from credulous superstition in what is *not* revealed; and strange to say, generally, the most credulous and superstitious people have been the most determined unbelievers in the invisible world revealed and made known to us in the Scriptures. The idea of invisibility or the power of man to make himself invisible or visible at pleasure, has always been a traditional belief in many nations, and in Britain was for centuries a received doctrine among the ignorant and superstitious. Thus a fern-seed, gathered at the right time, with certain charms, was believed to have the power of conferring invisibility on the possessor. Shakespeare says, accordingly

“We have the receipt of fern seed:
We walk invisible.”

How much ignorance and charlatanism had to do with such foolish tradition is seen in the origin of this superstition, which it is considered was owing to the belief (then received) that the fern had neither seed nor blossom, as neither could be detected by the eye (the seed not being noticed on the back); and therefore that these must necessarily exist in an invisible state, except once in the year; and at a particular time when they were to be sought with the hope of obtaining something very precious. And accordingly, in this instance, to the invisible fern-seed itself was attributed the power of rendering others who possessed it invisible, like itself. Sometimes, it

is said, the involuntary possessors of fern-seed rendered themselves invisible without knowing it: and a story is told of a farmer, in Belgium, who going out one evening to look for a foal which had strayed, received some of the seed which fell from the fern into his shoes. On returning home to his family, and entering the kitchen, he was surprised to find that his wife and children did not appear conscious of his presence; so at length (to test it) he exclaimed in a loud voice, "I have not found the foal!" On his uttering this, the whole family appeared terror-stricken; and he perceived evidently that he must be invisible to them. He accordingly began to think there must be some fern-seed on his person without his knowledge; and feeling something like small shot in his shoes, he sat down on a chair and took them off, when he immediately appeared, to the consternation and amazement of his family.

APPENDIX (2).

A CURIOUS and interesting example of the vast distances traversed by migratory birds came under the observation and experience of the writer.

For many years, as a child, he was intimately acquainted with a stuffed specimen of a large sea-bird, termed the Imber, or Great Northern Diver, about the size of a goose, which was in the possession of his father,—the late Sir Philip Crampton, Bart. This bird was shot in 1818, in Sligo Bay. When taken up it was found to have an Indian arrow infixed in the neck. The original wound had closed round the arrow and cicatrized, and so tightly that it could not be removed without incision. The arrow, which was of bone, tipped with copper, was broken short off: probably by the struggles of the bird to free itself from it; but the point had passed through the skin of the neck, leaving about six inches in all, or three at either side. On examination of the arrow, and comparing it with those in the Museums of Trinity College and the Dublin Society, it was identified as having been made and used by a tribe of

Indians inhabiting the shores of the Athabasca Lake, in North America. This Lake lies between the 60th and 70th parallel of latitude.

The conclusion therefore was evident and irresistible, that this bird must have traversed the enormous interval that separates the Athabasca Lake from Sligo, with the arrow in its neck, implying a distance of not less than a thousand leagues! Having short wings and a heavy body, and not being a very rapid flyer, it could not of course have accomplished such a journey without frequent rests,—especially with such an impediment to its flight: but this only makes that flight the more wonderful. What mysterious power urged and guided it onward, notwithstanding all difficulties and dangers, in one direction, from the first chance wound received from the flying arrow of the Indian, to the shot of the Irish double-barrel in Sligo.

The authenticity of this curious fact of natural history is undoubted: the bird having been exhibited in Sligo, publicly, by the gentleman who shot it, for several days. In the year 1864, however, the present writer, wishing to ascertain what had become of the bird, wrote a letter to a Dublin paper (*The Evening Mail*), describing the circumstances, and asking for information. To his great surprise he received a letter from the gentleman who shot it; but not any information as to what had become of it.

The following is a copy of a portion of that letter, which describes the particulars of its capture and its exhibition in Sligo:—

"STRAND HILL,

"28th January, 1864.

"DEAR SIR,

"I have been in Dublin for some days past, and have read your letter of the 23rd inst. I am the man who shot a bird with an Indian arrow in its neck, in the year 1818 or 1819.

"My boat was anchored in the stream between Coney and Oyster Islands, where I used to stay to shoot water-fowl passing

to the strand. We saw two large birds seaward, in the channel called Belgar, between Coney Island and Rossy point, near the Metal Beacon. They were near each other, and on going down one of them dived and got up at a very long distance from us. The bird with the arrow made no effort to escape, and I got quite near enough,—within thirty or forty yards,—when I shot it. The arrow must have been a long time in its neck. The skin was healed, and so hard the arrow could not be pulled out. We had it in the Island Home two or three days, when Mr. Charles Henery got it from my father to take to Dublin, where he was going next day, to have it stuffed. I cannot now recollect what became of it; but in this way we lost sight of it. If I get any information of its existence, I shall have much pleasure in communicating it to you.

“I am, dear Sir,

“Yours faithfully,

“G. W. MEREDITH.

“To Rev. Josiah Crampton,

“Killesher,

“Florence Court,

“Co. Fermagh.

“P.S.—In your letter received this morning, you say Mr. Henery claims the honor of having shot the bird for his father, but in doing so he is in error. What he says, however, of its having been exhibited in Sligo, is quite right. His father got the bird from my father. Coney Island is a large place, containing three or four hundred acres, at the mouth of the Sligo harbour. The Island Home is a mansion where members of my family have always resided.

“G. W. MEREDITH.”

The writer has since been informed that the bird was presented by Sir P. Crampton, to the late Lord Combermere, for his Lordship's Private Museum of Natural History: but he has not yet been able to discover it.

The following lines were written by a near relative of the writer, in reference to this interesting and beautiful anecdote of natural history:—

“*On a Great Nothorn Diver, shot in Ireland, and found to have an Indian arrow through the neck.*

“I stand in fancy on the plains
Beyond the Atlantic's furthest flow,
Where stretch the Indian's wild domains
To regions of eternal snow.

“There stalks the moose, there prowls the bear:
And now, when winter's reign is o'er,
The birds with clamour fill the air,
And seek their wonted haunts once more.

“Now o'er the desert's vast expanse
The wandering savage tracks his game:
His weapons rude,—a bow,—a lance;—
But matchless in his practised aim.

“See how the startled birds arise
From yonder lake. Now try thy skill!
Home to its mark the arrow flies,
And quivering strikes, but fails to kill.

“Conscious of pain and urged by fear,
The Imber's flight has known no check.
Is this a dream? The bird is here:
And see,—the arrow in its neck!

“A thousand leagues by sea and land
The wounded bird the arrow bore;
Then fell beneath the sportsman's hand,—
A trophy from a foreign shore.

“The Indian arrow, framed of bone
With copper tipped, reveals the place
Where range upon their deserts lone
The savage Athabasca race.

“Oh, wondrous gift! to gird the earth,—
To follow in its course the sun;
From frozen regions of their birth
O'er all the fertile earth to run.

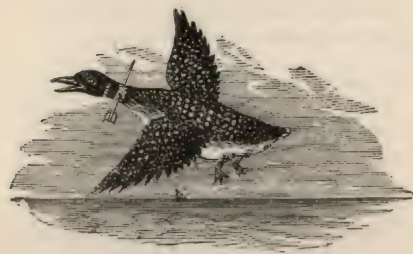
"Yet heaven its gifts on all bestows,
To meet the evils none can cure ;—
The power to fly from ill to *those* ;
To *others*,—courage to endure.

"Methinks in this poor bird I find
A type of one transfixed with grief,
Who leaving former joys behind,
Flies o'er the world to seek relief.

"No change of scene the wound can heal,
Tho' time perchance may ease the smart ;
Yet still condemned through life to feel
The arrow rankling in the heart.

1855.

"S. C."



THE SECOND HEAVEN,

OR

WORLD OF STARS.

THE SECOND HEAVEN,

OR

World of Stars.

CHAPTER I.

INFINITE SPACE.

"Snatch me, ye whirlwinds, far from human race,
Tossed through the void illimitable space."

POPE.

THE subject of the Second Heavens divides itself naturally into two parts: (1) The Heavens, or the infinite region of space in which the heavenly bodies are located and move; and (2), those bodies themselves,—constituting the world of stars or suns, planets, comets, nebulæ, ærolites, and all other material objects that are therein,—visible or invisible to us. Leaving the region of life, warmth, beauty, and sunshine, comprehended within our own terrestrial atmosphere, or first heavens, we now enter upon a different scene; and my readers are invited to accompany me in imagination, not only out of the world we inhabit, but beyond the protective ærial covering that is connected

with it,—out into the comparatively dark and cold and cheerless, but still beautiful, regions of infinite space.

There is something peculiarly solemn, and indeed awful, even in the *idea* of this first step out of the golden sunshine and blue sky of our cheerful world of life, into the profound and starry depths of the dark infinite beyond it. It is the thought of infinite extension, perhaps, that awes the mind. So long as we are within the limits of our own world, whether on land or sea, or even in the air, we are still conscious of a definite boundary to each and all; and this, to finite beings, suggests a different sensation or train of thought. It matters not how great may be the extent of an ocean,—such as the Atlantic, for instance: if we know (as we do) that there is a boundary to it *somewhere*, even though we cannot see it,—a shore which our vessel will at length reach, if we only have patience,—we look upon it differently. And so with the air. It matters not that in mounting through it (as in a balloon) we cannot perceive any boundary between it and space, it is sufficient to know that to *us*, at *least*, there *is* one; and that although to the eye it seems as though there were no impediment to our ascending to the moon or the stars, there is a safety point at which we must stop: there is a *celestial* as well as a terrestrial barrier in nature, beyond which we cannot go; and from which, when we have reached, we must return and descend to earth again. And the knowledge of this, gained by experience, alters the character of our sensation,—giving a feeling of definiteness and security, quite different from the contemplation of infinity. The air thus viewed becomes merely an appurtenance of the earth,—a part of terrestrial (or

perchance celestial) mechanism attached to it,—and is so felt to be. But be space what it may in its own nature, one step into it beyond the limits assigned to us, and the awe and solemn grandeur of infinity breaks upon us. We feel now in an endless, shoreless ocean,—a gulf untraversed by man; uncrossed, save by the wing of angel, and save as we have been enabled to look from our own world out into it, unknown to us.

We might perhaps realize this sensation if we could imagine that the entire of space was air, of a uniform density with our own; and that a balloon might be navigated through it to any distance; so that a man might go upon a voyage to the moon or a planet, as he now does to America or Australia. The sensation of such a voyage, if possible, represents the difference between the infinite and the finite, as a subject of contemplation. It is however providential that such voyages are not possible; and that the Creator has set a limit to human presumption and exploration beyond the precincts of this planet: or we might have frequently to record the perishing of many, lost in the dark depths of space above us; and to deplore the fate of many an aerial Livingstone, bound for the *real* "mountains of the moon."

But happily for us we can traverse this wonderful region without exposing ourselves to such dangers; and quietly seated at our fireside, or looking out through our telescopes on some calm summer eve, we can navigate the depths of space in comfort, and sound its starry profundities without peril or inconvenience. But curiosity would lead us now, in the first instance, to ask, *Whereabouts* is the boundary (if there be any) between

air and space? *i.e.*, Where is the last and faintest breath of terrestrial air to be found, and the first step into that mysterious void, called space, of which we know so little? The question recurs, Are air and space after all so utterly different in their nature, that there is a *defined boundary* to each, as distinct as there is between our seas and atmosphere; and, if so, at what distance from the earth is it to be looked for, and what of the nature of space itself? As it is not possible for us to approach within many miles of this ideal boundary, or to analyze the nature of space as we can air, observation by other means must determine this question.

Observation of the barometer, when carried upwards through the air, shows us, it is true, a gradual decrease in the *density* of our atmosphere as we ascend, in a regular proportion for every mile; so that it has been calculated that at this rate, if it continues so to decrease, air would cease to exist at about fifty miles from the surface of the earth. If this *were* the case beyond all question, then there could be no doubt as to where this definite boundary is; and the certainty that beyond this boundary was something *quite different*, which we have been accustomed to call, for want of a better name, space,—generally considered to be a vacuum in former days: *i.e.*, such as is found under the exhausted receiver of an air-pump,—an infinite extension of nothing. The researches of modern science however, and closer observations, have not only not confirmed this notion, but seem to contradict it. In the first place, the *idea* of air, which consists of various *substances called gases*, being *annihilated* at a certain distance, by its own tenuity, is not only improbable, but untenable, without special in-

terference. It might indeed be prevented from extending itself beyond certain bounds by the Divine fiat; but that it should cease altogether *in consequence of its extreme rarification from extension*, is not in accordance with the principles of sound philosophy or science, respecting the nature of matter; which, as it is capable of *infinite divisibility*, is also capable of *infinite extension*: and therefore, though inappreciable by us, there is no reason for not believing that the entire of space, called interstellar (as that medium is in which the stars and planets are placed), may not be composed of the *very same material as our own atmosphere*, only (being extended infinitely) of such a tenuity as to be inappreciable to us, even by the aid of the most delicate and the finest instruments; but nevertheless retained by the Creator at a standard-point of tenuity beyond which it should not go, and which would render it a medium best suited for the great and, infinite ocean in which the bright stars and suns and planets have to float, and derive their light from it as they move onward in their courses.

Now astronomical observation alone, in one particular, has shown the fallacy of the old plausible theory that appeared at first to be sustained,—of the entire and sudden cessation of atmospheric air at a certain point, said to be from forty-five to fifty miles from the earth's surface. The entrance of meteoric bodies into our atmosphere is attended invariably by their combustion. They take fire from their rapid passage through it, which offers a resistance to their progress sufficient to produce this effect.

But the heights of numerous *ærolites* have been taken; and the distance at which the combustion of

these bodies have been seen to take place has extended the point originally fixed upon by the barometer as the actual boundary of our atmosphere, to at least 200 miles, or more than four times the distance of former barometrical calculations. This, at all events, proves how unsafe a guide the barometer is here. But it may be said, Well: grant that air is extended so far as 200 miles of extreme tenuity; yet, at all events, as the meteors do not take fire *till they reach this point*, then the fact of a *distinct* boundary to our atmosphere at least here is still established. By no means, we reply. It is quite possible that air may truly exist far beyond this ideal boundary thus marked by the meteoric bodies, or even through infinity; but of too great tenuity to cause ignition in the meteor, till it had come to the exact point where the density and resistance were sufficient to produce the effect; although even *there* the density would be so slight as to be inappreciable except by such a test.

The doctrine therefore of a fixed line of demarcation, or a sudden boundary between our terrestrial atmosphere and the region of space, is, as I take it, not only *not proved*, but the probability lies in the opposite direction, as we shall see by another test; and that at all events (whatever be its nature) the old idea, that space is a *vacuum*, or *mere emptiness*, is quite *untenable*.

And here, *as in the former instance*, *meteors* and *aerolites* appear to have impaired the evidence of the *barometer*, as regards the cessation of air at a particular point and a definite boundary between it and space; as also by their combustion and ignition at vast heights, to indicate the presence of some at least of the con-

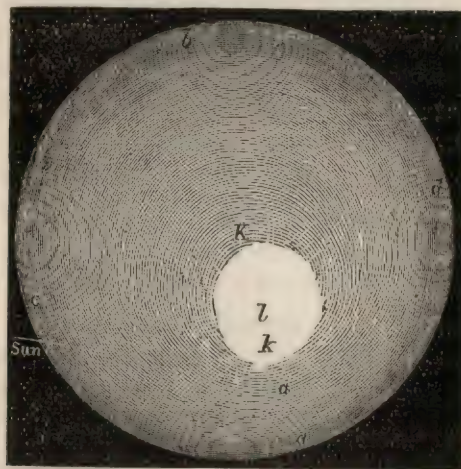
stituents of our own atmosphere* existing at these heights. So the evidence of other celestial bodies, of a different class,—of the very opposite, indeed, to the first as regards solidity, being the lightest bodies that we know of in the heavens,—afford a testimony of a different kind; but not less important, as bearing upon the same question,—viz., the existence of some *resisting medium* in the interstellar spaces: I mean comets. There are a vast number of these strange bodies, whose nature or purpose in creation we know but little of, obtaining but a transient glimpse of most of them, when, phantom-like, they depart into the depths from whence they came, many of them never to return to our wondering vision. Of all the heavenly bodies they are the greatest enigma; but nevertheless close observation has turned them to some account, and in nothing more interesting than the curious evidence afforded by one at least of them,—of the existence of a resisting æther, or medium, in the depths of space through which it passes.

This comet (called Encke's, from the name of its discoverer), unlike many of its companions, is a regular member of our solar system. It takes no flight of thousands of years from the sun after its perihelion, but steadily and quietly pursues its comparatively minute orbit of three and one-third years, approaching the sun at its perihelion to within 32,000,000 of miles (plunging within the orbit of Mercury), and again receding from him at its aphelion to 387,000,000 miles, or beyond the orbit of the asteroids; but obeying the laws of gravity as regularly as any of the planets, so that it has

* Oxygen and hydrogen.

afforded frequent opportunities for observation of its motions.

Now this comet (and indeed comets in general, according to Sir John Herschel) has not more density than the lightest summer cloud that reflects its golden tints at sunset. How wonderful then its obedience to the great Newtonian law, which, notwithstanding its light and flimsy gossamer-like body through which the stars can be seen, it so readily acknowledges! yet in this very



Encke's Comet.

quality it is that it becomes the indicator of the information we require respecting the medium in which it moves. It is an unquestionable fact, that while from the period of its discovery, in 1818, it has accomplished fourteen revolutions, all of which have been regularly observed, the period of its revolution is continually diminishing: in other words, its motion in space has been retarded, and is still being retarded; and as has been

justly concluded, retarded not by the attraction of any other body, but by the resistance of the medium in which it moves. A perfect vacuum, it is true, might have been imagined previously in the case of the planets, because their density would render the presence of so rare a fluid inappreciable; but a *feather* propelled by a great velocity might render obvious the existence, or rather *resistance*, of an ætherial medium or fluid, which would not be perceptible in the motion of a cannon ball. Accordingly a close scrutiny revealed the fact of a positive retardation of Encke's comet, from encountering some resisting medium in space; and the effect of which, from its first discovery until now has been considerable, has been measurable, and has actually diminished the time of the comet's revolution above two days.

The effect of such a resistance would be, by destroying a part of the projectile force, to cause the comet to approach the sun, and thus have its periodical time shortened; and the ultimate effect must be, unless counteracted by the attraction of some other body, to bring the comet nearer to the sun at every revolution, until it finally is plunged into his incandescent mass. Although the resistance is so slight that many thousand years may be required to accomplish that catastrophe, yet if nothing intervened to prevent it the result would be certain: but meanwhile other causes are at work in the heavens to prevent such result. It is easy to see that the effects of such a resistance may be counteracted by the attraction of one or more planets which it may pass in its sweep in returning to the sun; that such is (in respect of this comet a fact) in the arrangement of the Divine mechanism of the heavens generally, there is every reason to believe:

but what of the larger and denser bodies in the heavens? They afford, it is true, no evidence whatever of the existence of such a medium, or of any resistance; but it is evident that this arises simply from their *greater* density, and the great tenuity of the interstellar atmosphere which renders any resistance to their motions inappreciable by observation. But, nevertheless, if the theory be correct, or if it be a fact that there *is* a resisting medium, the same principle which would draw the light and flimsy comet into the sun would apply to every planet in the heavens, and every solar system where a planet moved. Though the time of the final catastrophe would be protracted for an inconceivable period in the case of such bodies, it would tell at last even upon *them*, and they too would share the fate of their lighter companions. That fate would only be postponed: they would be doomed, though not yet destroyed. But it is not so, as observation has proved; and a beautiful counteracting system of celestial mechanism prevents it effectually.

The great Newtonian law of gravity,—which provides that every body shall be attracted by another body within certain limitations, depending upon their mutual density and their distances,—has provided a wonderful system in the heavens of balancings and disturbances (called perturbations), by the attraction of other bodies, which effectually prevents the possibility of such catastrophes. Of this we have a remarkable instance in the path of the moon, whose circuit round the earth is at one time so much nearer to us than at another, that her path, if it were described, would be represented neither by a perfect circle, nor an ellipse or oval, but by a wavy

elliptic outline, as though she were (as indeed she is) the subject of contending powers,—the earth now drawing her to itself, and now the sun operating as a counterbalance: so between the two giants she pursues her course,—now yielding a little to one, now to the other. No sooner has she accomplished her descent to the earth than she begins her ascent again to the sun; thus, like a good ship carrying a light at her bow, she rides in safety over the contending waves of gravity, and ensures to us a continuance of her mild lustre during her apparently unsteady voyage. And so in like manner does the earth perform her voyage round her primary, and so every planet in the heavens. A system of perturbation and compensating forces is established, that permits the planetary bodies now to descend to Zero, as though they were about to sink into the sun and be destroyed; and now to rise again, as though they had never fallen. All this, which is well ascertained, prevents the possibility of collision in the heavens by any of the bodies there, from any cause; and brings before us a perfectly adjusted system of counterpoise, as effectual as a similar system is *made* to be by the ingenuity and wisdom of man,—as seen in some great steam-engine, when by counterpoising powers and weights the destruction of the machine is prevented, and safety ensured: one (speaking humanly), be it remembered, is the invention of *man*; the other, of God. And if it be admitted that in the *former* case intelligence, design, and calculation, are necessary to attain the object, so must it be in the *latter*; and the perturbation of every star and planet in the heavens presents an analagous system of Divine intelligence, design, and precision, from the Great Source of all intel-

lectual power, of which man is at best but the feeble, but still the true, exponent and representative,—bearing, as he undoubtedly does in this respect, the image of his Creator.

To carry this system of celestial mechanics out, it will be only necessary to adjust accurately the densities and distances and projectile radocities of the heavenly bodies, in due proportion to each other. This done, and the result would be, what indeed we know it actually *is*: viz., perfect order and security, perfect beauty, perfect peace in the heavens, without the *possibility* of a collision or a catastrophe. Now, then, we have a glimpse of the heavens as regards the order conspicuous therein; and if we write upon all these wonderful balancings and adjustments the one word “INFINITE,”—how overwhelming the thought!—how must it add to our conceptions of the grandeur of the scene! Behold crowds of golden suns pursuing their way; and silvery planets, with their attendant moons, moving on in perfect order and silence, like a mighty host marshalled together; each performing its appointed course, and dealing out its measure of attractive power to others or receiving it itself, with perfect precision and without fail: stars, planets, comets, nebulae, clusters,—all steering their own way through the vast abyss, without ceasing or striking, without an error in their course of a hair's breadth! What material is here for the thoughtful mind of man!—what food for the mathematician, the philosopher, and the Christian! To the latter indeed,—who sees reflected in those silent worlds, yet *speaking* in every movement the glory of their Maker,—a glittering volume is unfolded, every page of which is not only instructive, but

intensely interesting; and when he is acquainted even slightly with its grand and simple truths, he only wonders that the mathematician or the professional man of science should have had so long a monopoly of its glories. He feels that such knowledge should be the property of *every man*, who, in the words of the inspired Prophet, is invited to contemplate it in the following significant apostrophe: “Lift up your eyes and behold Who hath created these things, that bringeth out their host by number: He calleth them all by names by the greatness of His might, for He is strong in power; and not one faileth.”

But returning to the consideration of the nature of space itself, it would appear then that so far from being a vacuum (as formerly believed), it is a *plenum*, full of matter,—which, however great its tenuity, it is probable not only exists within the bounds of our solar system, but extends through infinity. Of what it is composed can never be known by man for certain; but its existence being detected in the interstellar spaces, conjecture may lead us to believe naturally that it is not very different from the very atmosphere we breathe in a denser form,—in fact, is but a continuation of it, expanded through infinity: and this indeed is the verdict which modern science seems to have pronounced, so far as rational conjecture is entitled to any weight. The recent marvellous discoveries by the aid of the spectroscope, as to the materials of which the stars and planets with their several atmospheres are composed, have led to the magnificent conclusion that the *materials of the entire universe are the same*, only differently distributed, and in different conditions of being. Whether

solid or fluid or gaseous,—whether sun, planet, comet, or aerolite,—their atmospheres or oceans, and their varied productions or inhabitants, all are but components of a limited number of substances, in different states and degrees of combination.

The constitution of the planet Mars, for instance, has been identified with that of the Earth in every particular; and his snow-clad continents, his ice-bound poles, his moving clouds, and sea-green oceans, attested long since by the eye through the telescope to be in all probability what they seemed, have been demonstrated by the still more wonderful instrument that succeeded it; and the spectrum of Mars now proves beyond all doubt that he possesses an atmosphere, the constituents of which are identical with our own. And so, in like manner, so far as spectroscopic observation has extended, it is found to be the case with every planet and every sun and every star in the heavens, and every atmosphere there: they are but repetitions of our own sun-star, ourselves, and our atmosphere and oceans;* with some variety, it is true, in the *number* and *proportion* and *arrangement* of the constituent, as also the particular creative stage at which they have arrived,—but still the same as to general constituent; no substance which can with truth be called *new* being yet discovered.

Now, wherefore is this wonderful agreement or likeness in all material bodies in the heavens, which, let the eye and the telescope roam to the most distant star within

* The oceans of our earth, it is believed, are but our *atmosphere condensed*; and have a *celestial*, rather than a *terrestrial*, origin (as was once supposed.) Hence, in sea or on land, in sky or in star, the fundamental materials will be found alike, the *form* and mixture only different.

our vision, still sends back through the spectroscope the same strange story,—silica, carbon, oxygen, hydrogen, nitrogen, sodium, iron calcium, copper, nickel, zinc, magnesia, barum, phosphorus, sulphur, and other substances,—all of which we are familiar with here, either in a solid, fluid, or a gaseous state?—whence comes this strange identity, if it be not the fact that there is not only nothing new (as Solomon says) *under the sun*, but in any sun or star,—nothing new in the heavens or on the earth? Nay, that the very material in which these solid or flaming bodies in all their apparent variety float and move, is the very substance from which they derive their own being,* or from which they have been created or formed: viz., the material with which space is filled,—that thing which we used to call *space*, *emptiness*, *nothing*; but which may with more truth be termed atmospheric-matter,—the material of which every body in the heavens is composed through infinity.

True, the atmospheres round suns and planets are dense, as round our earth; and in some cases are partially solid, as in our sun, round whose fiery body it is generally thought speed countless millions of aerolites, constituting the sun-dust (as it may be termed) of our great luminary, or portions of his atmosphere solidified in innumerable planetary bodies of various sizes,†—the

* In agreement with this is the remarkable statement of the Apostle in the Epistle to the Hebrews, where he says (Heb. xi. 3), “Through faith we understand that the worlds were *framed* (κατηρτισθαι: i.e., *formed, arranged, completed*) by the Word of God, so that things which are *seen* (i.e., the worlds referred to) were not made of things which do appear.”

† While writing the above, the intelligence has arrived of the re-appearance of *Vulcan*, believed to be an intra-solar planet, having its orbit within that of Mercury. This body, it will be remembered, was seen by

solid fire-chips from the great solar lathe, as it whirls on its axis or moves onward.

But these solar or planetary atmospheres are probably but envelopes composed of the matter of space gathered round them in a richer condition than it exists when diffused and extended through the universe,—gathered there by their gravity, which attracts it to their surface, as well as by their rotation and rapid progress onward, through the ocean in which they float, constantly maintained by the resistance of that medium, and the speed with which they move through it. If this be the case, it invests the subject of space with an interest it had not before: it will serve to explain many a problem that could not be solved by other means. Here perhaps will be found, in this supposition, the basis of the undulatory theory of light: not a substance, but a force or energy called into action by the vibrations of the universal atmosphere, as sound is called into being by the vibrations of a denser form of it here. Here, too, would be explained that which has been the subject of so much unprofitable and vain conjecture: viz., the origin and source of the infinite supply of light and heat to the sun, and all the countless millions of stars that, like himself, are burning and blazing on every side of us for ever, without any intermission, or apparent means of supply or support. If the medium in which they

Dr. Lescarbault, its discoverer, about seven years ago, but has not been seen since; and though Le Verriers was much interested by the supposed discovery, and visited the Dr. in his humble observatory for the purposes of investigating the facts of his discovery, yet doubts were thrown upon it at the time, and since then no one has seen it. The intelligence now however from India, where it was seen distinctly by Mr. Podgson, and its elevation calculated, puts the matter beyond doubt.

exist is the source of that supply, there would be a solution to the difficulty. They have infinity to feed their fires: there is no danger, therefore, of their being extinguished. They are not lights themselves, but light-receivers,—“light-bearers,” as our sun is justly termed in Scripture,—if the ether in which he swims is the undulating light which we receive, and which he dispenses: invisible and dark and cold, till collected round, and agitated, and chemically united with him, as a vast receptacle for light and heat. Then, in this view, space is but hidden light,—a concealed and infinite ocean of fire,—breaking out and appearing on every star and planet that, newly-formed, is constantly added to the dominions of the Creator, and reflects His glory.

It may be thought that the tenuity of the interstellar atmosphere would be such that its gravity could not be ascertained. Yet it would appear that, whether correctly or not, it has at least been calculated; and that the quantity of it which our earth would displace by her bulk has been computed to weigh but 250 lbs., and 1,000 cubic miles of it would weigh but seven grains. But this would rapidly be altered in the case of solar and planetary atmospheres gathered round their circumference as they rush onward through space. Our own sun, for instance, it is calculated, is moving on, in an unknown and vast orbit of his own, at the rate of 500 miles in a minute; and although his course through it would not be perceptibly retarded, yet an accumulation of the matter of space must take place around him as a consequence; while the vast power of his own gravity would attract oceans of fresh matter continually on to his surface,—increasing its density enormously in the

region around him compared to the rest of space, and causing (partially at least) that violent agitation in his incandescent fiery mass which is visible to the telescope. Thus the solar fires would be constantly fed, were there nothing else but his own gravity and his own motion to feed them.

The contact of the various gases (amongst which oxygen is conspicuous in our own atmosphere, and doubtless also in space, while the sun itself gives evidence by the spectroscope of vast quantities of hydrogen) would generate an infinite and continuous combustion. Meanwhile the gravity of all the planets that encircle him (the influence of which is felt sensibly, and is exhibited by our great luminary in the outbreak of spots answering instantaneously to our magnetic storms *here*) would keep up and help to sustain the conflagration on his surface by a system of reciprocal magnetic power, which indeed is already sufficiently apparent in the case of our own earth.

Thus the existence of an atmosphere composed of the same materials as our own, in the depths of space, may be rationally conjectured; while the fact of its existence would explain the hitherto insoluble problem of the feeding of the sun-fires.

But that which would happen in the case of the sun could only be applicable partially to the solid planetary bodies. The same gathering of the atmosphere of space, it is true, would take place around them, producing the condensed atmosphere which we have, as well as our oceans; but there would be here no combustion. The condition of the cold and solid planets differs from the molten and incandescent mass of their primary, upon

which constant cataracts of atmosphere are poured from the regions of space. The motion of the earth, it is true, through that medium, both in her *doubly-onward** progress and by her rotation, may produce (and probably does) many of the magnetic and auroral phenomena which we behold, and many other effects perceptible in our altered temperature and seasons. But more than this cannot take place, the cold and solid planet resisting it; and by its gravity only accumulating and condensing it around it, without causing combustion.

Were the earth indeed not thus solidified, the same effects would be produced upon it as are found in the sun, or in any planet in a fluid or gaseous state: would present, but a burning glowing mass. How far this is the case with some of the larger planets, such as Jupiter and Saturn, is at present the subject of interesting speculations by modern astronomers, some of whom suppose them to be in their present stage in a molten state, like smaller suns, and consequently uninhabitable. I cannot but think, however, that it would be premature to decide upon so important a matter, upon the amount of evidence as yet given upon it, in the case of such distant bodies. But the great question still remains for investigation, whether in a molten or a cool and solid state, and is applicable to suns and stars as well as planets,—viz., whether their atmospheres are not composed of the aggregation or accumulation around them respectively, of the aerial or otherwise medium in which they float,

* It must be remembered that the earth has not only her own proper motion onward in her own orbit round the sun, but likewise partakes of the onward progress of the sun, which carries her with him through space.

attracted to them by their own gravity in their onward progress through space.

This medium, if it exists, must be universal, and be distributed by gravitation proportionally to every star in the heavens. This hypothesis has been put forward with great clearness and power by a recent writer. Assuming the elastic medium in which an infinite number of suns and planets are moving through the regions of infinity, and deriving their atmospheres from it, he is enabled by a simple rule to calculate the actual atmosphere of any one of them; the amount of that accumulation depending upon not merely "the gravity of any *one*, but the resultant of the counteracting gravity of others,"* which are sharers in or feeders on this wonderful atmosphere,—“breaking it,” as Mr. Williams terms it, perpetually.

Thus, taking the mass and atmosphere of the earth (which we are already acquainted with) as his units, and knowing the amount of its appropriation by our planet from the general stock, and the relative proportion of the masses of the earth and the other members of the solar system, the atmosphere of any one of those bodies, he maintains, may be calculated without difficulty. When this hypothesis is tested in the case of the atmospheres of some of the planets with the results of actual observation, it is at all events found to agree in a remarkable manner with the facts already ascertained; while whatever may be thought of it, it cannot but afford a most interesting subject for speculation: and from this investigation (assuming its truth) we should obtain a

* “Fuel of the Sun,” by Williams.

wonderful glimpse of the material world,—“The Second Heaven, or World of Stars.” Looking only at the medium in which they move, that medium would be to the stars what our air-medium is to us,—their life, their breath, their very existence; without which they would be instantly extinguished, and also their inhabitants perish,—without which no light-waves would pass from star to star and planet to planet, rippling in tides of glory against the surface of the island worlds of space that plough through its depths. Without it the universe would be cold and lifeless, as well as lightless; the regions of space, instead of being (as they now are) lighted by millions of sparkling fires and filled by the broad blaze of countless suns, or illuminated by the soft reflected light of planets, with stars of every colour and hue of glory, would present but the blackness of darkness for ever. If space was not itself, in some way, at once the medium and fountain and source of light, the brightest sun that ever shone would not extend a ray of light beyond its own surface; and the region of space, notwithstanding its millions of lights, be perfect darkness.

In this view of the matter, the importance of the doctrine of the unlimited extension of a *light-bearing*, or light-originating, atmosphere, like our own, through the universe, cannot be overrated. How it could have remained so long unthought of, and the critical consideration of it so entirely neglected during the last half century of unexampled philosophical inquiry, is a matter of astonishment to Mr. Williams, who regards it as the “most important and fundamental inquiry in the whole range of physical science;” and accounts for

its not being adopted by the habit of accepting unquestioned the conclusions of a great mind, instead of examining the subject independently on its own merits. The theory of the sudden cessation of all atmospheric air at forty-five miles above the earth was originally established by Dr. Wollaston, in his remarkable paper on the atomic theory, in which he asserted that there must be a definite boundary to our atmosphere upon that theory.* "The high character and reputation of so eminent a philosopher doubtless occasioned," says Mr. Williams, "the unquestioned acceptance of his theory and conclusion upon a subject to which few at that period cared, or were competent, to examine too closely; but nothing in these days will be received without the strictest scrutiny." How far such an investigation will confirm or overthrow Dr. Wollaston's theory remains to be seen.

But the notion of a universal luminiferous ether pervading space is not now, for the first time, made known by Mr. Williams. Nearly all astronomers have recognised its probability for the last half century, and it was put forward strongly by Dr. Whewell in 1833. The undulating theory of light, indeed, which had superseded the Newtonian theory of emanation, required some such luminiferous, all-pervading medium; but neither the identity of that medium with the very atmosphere in which we are plunged ourselves, and which we are breathing in a denser form, nor the application of it as the feeding or breathing ocean to star or planet, has been

* "On the Finite Extent of the Atmosphere," by William Hyde Wollaston, M.D., V.P.R.S. Read January 17th, 1822.

advanced before so clearly and boldly as by Mr. Williams. In the theory itself, indeed, I cannot but think may be perceived the dawn of a new era as regards astronomical research; and with it the fullest exhibition of the glory of Him who hath created all things perfectly, and to whose glory even this—the dark and silent depths of infinite space—can testify.

CHAPTER II.

INFINITY OF SPACE.

WE pass now to the consideration of the *infinity* of the medium called space. *Infinity*, which means simply "without end," is one of those ideas from which a finite Being like man shrinks; he may receive it as a *fact* that cannot be disputed, and even conceive its possibility; but follow up the idea of infinite extension he cannot, nor is it probable that any created Being can. Whenever we attempt it, indeed, we find ourselves involuntarily imagining a boundary to it; but when we have reached that boundary, and overleap it, the question presents itself again and again, What of that which is *beyond it*? for we cannot but feel that there must be "a *beyond* to *it*, and every successive boundary, and so on, for ever; until, as we think of it, the head reels, and the imagination sinks and fails before the thought. It cannot be sustained; and all powers of description equally fail, whether infinity be applied to *time* or extension of *space* or motion. *Time* (or duration) and *space*, indeed, viewed in the light of *infinity*, blend one into the other, and are used indifferently by astronomers in measurements of space, the clock or the transit of the star representing both alike.

To form even a feeble notion of the realms of infinite space, we should have a practical experience of it, such

as doubtless the angel Gabriel and others of those glorious Beings had, in their journey from its distant regions to and fro from their habitations to this planet.

But though we ourselves can have no possible experience of it, our imagination may, in some degree, picture such a journey; and this has been done by one of the most imaginative and ablest writers of the past century, who describes not only the appearance of such a flight through starry space, but the probable effect produced upon a poor finite creature under such circumstances. I refer to Jean Paul Richter, a celebrated German Philosopher of the past century, who pictures such a journey in language the power and sublimity of which seems all but inspired. It is entitled, "A Dream of the Infinite as it reveals itself in the Chambers of Space" (quoted and translated by De Quincey partly from memory).

"God called up from dreams a man into the vestibule of heaven, saying, 'Come thou hither and see the glory of my house;' and to the servants that stood around His throne He said, 'Take him and undress him from his robes of flesh, cleanse his vision, and put a new breath into his nostrils: arm him with sail-broad wings for flight; only touch not with any change his human heart,—the heart that weeps and trembles.' It was done: and with a mighty angel for his guide, the man stood ready for his infinite voyage; and from the terraces of heaven, without sound or farewell, at once they wheeled away into endless space. Sometimes, with the solemn flight of angel wing, they fled through Zaharah's of darkness,—through wildernesses of death, that divided the worlds of life. Sometimes they swept over frontiers that were quickening, under prophetic motions, towards a life not yet realized; then from a distance that is counted only in heaven, light dawned for a time through a sleepy film. By unutterable pace the light



A DREAM OF THE INFINITE.

BY PAUL JEAN RICHTER.

"Angel, I will go no further."

To face page 137.

swept to *them*: *they*, by unutterable pace, to the light. In a moment the rushing of planets was upon them; in a moment the blazing of suns was around them: then came eternities of twilight, that *revealed* but were *not revealed*. To the right hand and to the left towered mighty constellations; that by self-repetition and by answers from afar, that by counter-positions, that by mysterious combinations, built up triumphal gates, whose architraves, whose archways,—horizontal, upright,—rested—rose—at altitudes, by spans that seemed ghastly from *infinitude*.

"Without measure were the architraves, past number were the archways, beyond memory the gates. *Within* were stairs that scaled the eternities *above*, that descended to the eternities *below*. Above was below, below was above, to the man stripped of gravitating body: depth was swallowed up in height insurmountable, height was swallowed up in depth unfathomable.

"Suddenly, as they thus rode from infinite to infinite,—suddenly, as thus they tilted over abysmal worlds,—a mighty cry arose that systems more mysterious, worlds more billowy, other heights and other depths, were dawning, were nearing, were at hand. Then the man sighed, shuddered, and wept; his overlaid heart uttered itself in tears; and he said, 'Angel, I will go no further, for the spirit of man aches under this infinity. Insufferable is the glory of God's house: let me lie down in the grave, that I may find rest from the persecution of *the infinite*; for end I see there is none.'

"And from all the listening stars that shone around issued one choral chant: 'Even so it is: angel, *thou* knowest that it is,—end there is none that ever yet we heard of.' 'End is there none?' the angel solemnly demanded: 'and is this the sorrow that kills *you*?' but no voice answered, that he might answer himself. Then the angel threw up his glorious hands to the heaven of heavens, saying, 'End is there none to the universe of God: so also there is no beginning!'"

This sublime description by one of whom it has been justly said, that "as a man or an author he was one of the most wonderful phenomena that Germany ever

produced," conveys to the mind, perhaps as far as any human description could picture it, a faint *idea*, so far as it could be received by a finite creature, of *infinity*: viz., that THERE IS INFINITY OF SPACE. Beyond *that* science cannot go. And even, *that* single idea in itself is overwhelming—overpowering—to the mind of a creature. The magnificent flight of the angel and his companion (as here drawn) through endless constellations, now suggests another important reflection: "Is there then a *corresponding infinity of stars* as of space? If it were possible for us to travel on for ever through its regions, is there any part of them where *constellations* of suns, and blazing clusters of stars, and rolling planets and ghostly comets, and milky nebulae, and fiery aerolites would not be found? Arguing from what we see and know, the probabilities are strong that as there is *endless space*, so there are *endless worlds and endless matter to occupy it* (i.e., composed of it); and that there is no part of the universe where it would be possible to go where such material objects would not be found,—where He who formed and is still ever forming worlds innumerable, does not behold the work of His hand. The doctrine that space is but the material for building worlds, as already shown, would confirm this amazing probability. But we pause here for a moment to breathe, overwhelmed by the flight we have had. Here are the dominions of the Almighty, into which we have but taken a single step over the threshold of the "Second Heavens," and feel ourselves all but lost,—*annihilated*. Here are its heights, and depths, and lengths, and breadths: who shall measure them?

CHAPTER III.

THE STARS.

LEAVING the consideration of infinite space, we now turn our attention to the nature of the bodies that are to be found there.

The heavens, although presenting a perfectly calm and tranquil sight to the unobservant, to the eye of the astronomer exhibit a busy and active scene,—constant motion being its first and prevailing element,—unto which we ourselves (*i.e.*, our planet) contributes not a little; the chief or apparent motion of all the stars being caused by the rotation of the earth on its axis. But setting this aside altogether, it may be truly affirmed that there is not an object that meets the eye in the heavens that is not in incessant, restless, continued, and rapid motion. *Fixed* as the stars appear to be in their constellations, so that their shape and conformation never changes to the eye, the results of modern science tell us that they are not so: their apparent fixedness proceeds entirely from their vast distance, which renders their proper or separate movements imperceptible. With the planets, proof of motion is unnecessary, as it is apparent at once to the eye: so also with the comet and the aerolite.

Nebulæ and clusters may be included among the stars; and appear not only to have a proper motion

for every star, but an aggregate motion of the entire cluster or firmament: *i.e.*, when the former are to be classed as *firmaments*, which the spectroscope has revealed not to be the case in all instances,—many of them being but gaseous masses of matter. But the result of a glance at the heavenly host, to a practised eye, under any circumstances, reveals a scene of universal movement,—sun balancing sun, and moon moon, and planet planet, and doubtless system system; while the command for all is *Onward: never cease!*

Much of the interest of astronomy is derived from the investigation of these movements of the heavenly host,—especially interesting to the mathematician; but without any mathematics, the general knowledge of them is interesting to any man. Let us then, taking each class separately, direct our attention to those bodies that are most numerous to the eye when we look at the heavens. These are what have been formerly called, and are still called for distinction sake, "*The Fixed Stars*;" but which are, as we have already remarked, no longer to be considered as fixed or motionless. The first question which arises is, What are they? To this astronomy replies, without any hesitation,—As to their nature, they are suns, one and all: they look, it is true, to the eye, but scintillating sparks; but they are actually suns, resembling our own huge star which we call the sun; which, vast as it is, appears but a scintillating spark to others, and in actual magnitude, it is believed, is far inferior to many that we see. Of their nature or composition we shall speak hereafter; but at present we may remark, that, whatever they are or may be, they form the chief features in the heavenly land-

scape. They seem to be, by their *numbers*, the great representatives of the material creation. Other forms and strange shapes there are to be found in the depths of space: but these are the chief *element*, so to speak, in the *heavens*; and as to number, innumerable. The number of stars, indeed, to be seen on a bright night with the naked eye, is by no means innumerable; and numerous as they appear, may be easily counted, and *have been*,—the utmost that can thus be seen not amounting to more than 5,000 or 6,000 for the entire hemisphere; and therefore *half that number* for the hemisphere that belongs to us, which is all that can be visible to the eye at one time. Not so, however, when the telescope is brought to the aid of the eye: then, indeed, they become past counting; and the number which we imagined when we looked up without its aid, becomes then a reality,—an infinity of stars breaks upon the sight. Calculations, it is true, have been made as to the probable number, including even the telescopic stars: but such calculations can only be an approximation in reference to particular districts in the heavens, respecting which it may be affirmed there *cannot be less* than a certain *number*; but beyond this all is conjecture. And as to the *millions* that now lie *altogether beyond the reach of the most powerful telescope*, what can be affirmed?

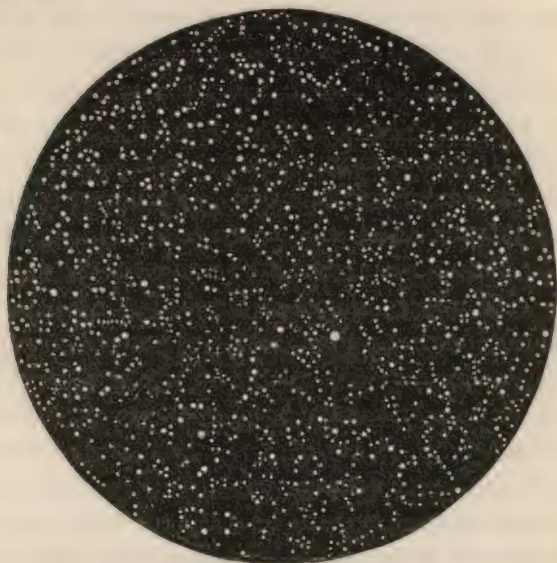
According to Argelander, the director of the Observatory of Bonn, stars of the seventh magnitude, which are always invisible to the naked eye, comprise 13,000; the eighth magnitude, 40,000; the ninth, 142,000. The total number of stars visible in the heavens, according to the strictest calculation by the aid of Sir William

Herschel's forty-feet telescope, is given as more than twenty millions: but there is little doubt that this is but an approximation to the truth, and that these numbers are far below the real ones.* It will be seen, too, that the *richness* of the heavens in stars is very unequal in different parts. The bright zone, known as the milky-way, containing, according to Sir William Herschel's calculation, *eighteen millions*; while Chacormac's more recent investigation makes it *seventy-seven millions*.† The superiority of modern telescopes, however, accounts in a great measure for the discrepancies in the calculations of astronomers. Even Sir William Herschel's forty-foot telescope, powerful as it was, could not compete with many instruments of a smaller size in the present day, setting aside Lord Rosse's greater telescope as an exceptional case. But there is as much difference between an inferior telescope and a really good one, as there is between the naked eye and a telescope of even moderate pretensions: and there are few sights indeed more wonderful or striking than the transformations produced by *looking first with the naked eye* at some groups or clusters or constellations of stars, and then with a telescope of even moderate power, at the same object. Such an instance is afforded in the constellation Gemini, or the Twins. Here the naked eye can perceive but six stars; but point to the same spot a telescope of six inches, and no less than 30,205 stars appear, of the thirteenth magnitude *alone*: but the entire space revealed here appears a mass of luminous points; and doubtless were a still more

* Guillemin.

† Ib.

powerful instrument to be applied, the eye would discern at depths all but infinite myriads of stars of smaller magnitude.*



A part of the constellation Gemini, as seen through the telescope.



The same seen with the naked eye.

Most of the stars visible to the naked eye may be easily known and recognised by any attentive observer, by the popular classification into constellations or clusters: viz., the groups into which they seem to resolve themselves to the eye of man,—who, from the earliest ages of the world, have traced out the fanciful representations of men, birds, beasts, and creeping things, in the shapes which they assume. These groupings, which form a kind of key to the

astrographical knowledge of the starry heavens, and which are spoken of by the sacred writers, and even (some of them) mentioned as early as the book of Job, are of more importance than being merely a guide to the knowledge of the stars. Every child is familiar with some of them which catch the eye at once, such as Ursa Major, the Great Bear (or as it is sometimes popularly termed, the Plough), which is the guide by which the Polar Star may be found. Then there is Orion and his belt, containing thousands of brilliant stars; and also the huge Nebula so well known in the Sword-handle. Then there is the celebrated cluster of the Pleiades, the supposed seat of the central sun, both of which are mentioned in the Book of Job: likewise Cassiopæa and Andromeda,—the latter containing a strange misty nebula, as yet *unresolved*, and seeming by the analysis of the spectrum to be *chiefly gaseous*. Those which are sufficiently conspicuous, most people, who take even the slightest interest in the subject, have seen and are familiar with. There are however numbers of others much more difficult to find, and which require the experience of years and a practised eye to recognise. But, it may be added, there is no employment more delightful, or that repays one more, than thus tracing out the strange configurations and apparent associations visible even to the naked eye; but with the aid of a telescope, even of moderate power, the interest will be greatly increased. There is something peculiarly satisfactory in identifying a star or a cluster or a constellation with those depicted on a good map; and it is to be regretted, indeed, that often the representations on the maps are not always as faithful

* "Guillemin Lockyer."

as they ought to be. But notwithstanding all the helps that have been provided for this purpose, it is wonderful how few have attained the knowledge of these constellations; and fewer still the relations of their groupings, of which it may be truly affirmed, that, in the case of many, they are not the mere fanciful suggestions of explorers, or a human arrangement for their convenience, but (in many instances, at least) a Divine and *real* mysterious relationship existing between star and star of many a group, which intimates that they have been placed in that relationship or configuration *with an express intention and purpose*, as evident as in the case of the members of our own solar system. That this is indeed the case, the discovery and close scrutiny of what is called the proper motion of individual stars has brought to light. This discovery is nothing new; and to Sir William Herschel, the most indefatigable of observers, must be ascribed the first positive proof of the proper motion of the stars, educed from observation of what are called now the binary systems, or systems of two stars, one revolving round the other.

These systems of revolving suns, for such they are, which are to be found among what are called popularly *double stars*,—*i.e.*, when what appears to the naked eye as a single star resolves itself into *two stars* with the aid of the telescope, or when even with the naked eye two stars appear in close proximity to each other. Formerly their juxtaposition was thought to be merely owing to their visual position with reference to one another, as regards the line of sight, or their perspective; but to the sagacity of the greatest of astronomers, and the accuracy of his observations, is due the rejection of the

old hypothesis (at least in a vast number of instances), and the wonderful truth demonstrated of actual physical connection between the members of these binary systems, in accordance with the great Newtonian law of gravitation by which they were found to be governed, and which revealed the magnificent result of sun revolving round sun. And instead of the casual scattering of stars, as it were sown broadcast in the heavens, and immovable, it was demonstrated that at a distance almost inconceivable from our own system, innumerable suns and systems of suns existed, rising from binary to more numerous and complicated systems, each revolving round the other with motions of really vast swiftness, such as is found in our own planetary system; but from their distance, as well as the gigantic size of their orbits, appearing to us to move with slow and majestic movements, and doubtless carrying with them their own planetary satellites, invisible to us from the distance, and their inhabitants (if any) enjoying, by reason of their strange position, the enlightenment of two or more suns as the case might be.

This discovery of the binary system was but the suggestion to that of larger and more complicated associations. Accordingly, the idea was verified by the discovery of *triple*, *quadruple*, and *quintuple systems*, until at length, still rising, *crowded systems of suns* appeared, where hundreds, even thousands, of stars are found congregated and compacted in so small a compass that their proximity can not properly be attributed to the effect of *accident*. On computing the chances indeed of such an accidental congregation in such clusters of suns, there would not be one chance out of a million in

favour of it; and we are forced to the grand conclusion that there are *hundreds of* suns, *many* of them much brighter and larger than our own, revolving round each other, and each surrounded by its own subordinate worlds, and united by gravitation into one grand system; but this, again, in the case supposed, is only one of millions upon millions of other similar systems and combinations. Thus viewed, the heavens assume to the astronomer quite a different aspect from that which they would to a casual and ignorant observer, and instead of a chance broad-cast scattering of star-seed above, in which apparently accidental proximity or gatherings and clusters might occur, as would be the case in uneven sowing of corn, he sees an *intelligent* and *intentional* system of grouping, from the binary *pairs* of suns upwards to the most *crowded clusters*. He is enabled to perceive their motions, and even *calculate* their mighty *orbits*, and ascertain their *material relations* to each other; to know their *conjunctions* and *separations*; to tell, whether uniform or different, the direction of their courses as they drift on in space,* as the snow flakes are driven by the wind

* *Star-drift*, or community of proper motion among the various constellations and groups of stars, has been ably pointed out by Mr. R. Proctor in his admirable work, "Other Worlds than Ours." This community of motion, or each separate star drifting in the *same direction*, though at different rates of motion, owing to their different distances, indicates (as Mr. Proctor conceives) a physical connection between these members of the group. A remarkable instance of this is afforded in the constellation "Ursa Major," where five of the principal stars and three of the smaller ones are found to be moving in the same direction; while the sixth, or uppermost of the two principal stars (termed the leaders to the Polar Star), has an opposite and special direction of its own, although apparently forming part of the same group. A still more striking instance of star-drift is pointed out by Mr. Proctor in the constellations of Cancer and Gemini, where the parallelism of motion, which is illustrated by a plate, is most

or circle in the whirlwind,—to tell what star *belongs* to another *star*, or *system* or *cluster*, and is as firmly bound to it as our own globe is to our own sun. He is enabled to solve the mystery of many a strange shape and form called a *constellation*, and once supposed to be *accidental*, and only so called because as a group it caught the eye; but he will be able to tell you that, in many instances at all events, the arrangements were designed; and there exists not merely an *optical*, but a *real* physical connection by the great law of gravitation, between the members of many a constellation and many a glowing cluster, united as an astral family in the heavens. How this enhances the interest with which we look at the heavens can easily be understood. The difference will be as great (to illustrate great by small things) as that which would be experienced in looking at a waste field of scattered weeds, or a flower-garden divided into parterres, where grow flowers of every hue, giving evidence of an intentional and relative arrangement of beauty and colour and form, and designed with all the skill of our best horticulturists. The impression at once of intelligent design and arrangement running through the various starry combinations in their wondrous orbits, becomes overwhelming, and is certainly not the least of the charms which the astronomical aspect of the heavens presents to the intelligent and thinking mind.

About a century ago not more than twenty double stars were known. And their real conjunction then was

striking. Now, assuming the amount of proper motion for each star, in 36,000 years a variety in amount will be found commensurate of course with the varying distances of the stars.

looked upon as purely optical, the result of perspective. Now we have a catalogue numbering 6,000, and out of them 650 have been demonstrated to have a physical connection with each other, two suns turning round a common centre of gravity. The separation of this class from those that are merely optically connected can be easily ascertained by observation of the actual movement of one round the other. Among these Castor, in the constellation Gemini, or the Twins, has been always considered as one of the most prominent; and an entire revolution of his system has been observed to be completed since 1780. Recently, however, Struve has discovered a third star belonging to this system, and which participates in the movements of the other two. Here there is properly speaking a triple system, where *two* suns are accompanied by a *third*, fifteen times more distant from the first than is the second.

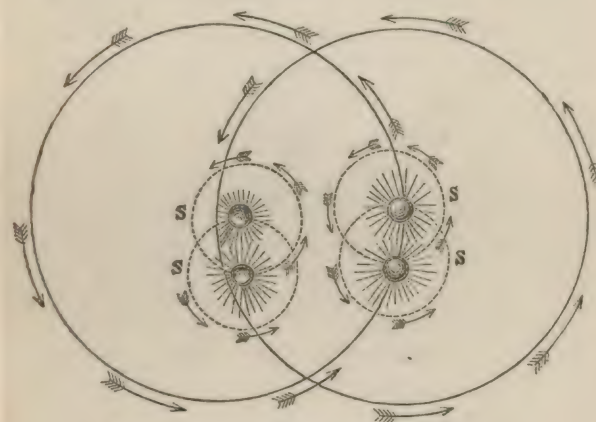
The revolutions of other binary systems have been likewise completed since the same date, 1780, among which are η Cassiopœa, μ Serpentaria, ξ Ursa Majoris. The orbit of this last binary has been ascertained as 61 years, its two components being one of the fourth and the other of the fifth magnitude: its orbit is of an elliptical or oval form. The orbits of other stars of this class which have been determined are as follows:—

ξ Hercules	-	-	36 years.
ζ Cancri	-	-	59 years.
μ Cœræ Borealis	-	-	66 years.
γ Ophiûdi	-	-	92 years.
ν Virginus	-	-	150 years.
δ Cyni	-	-	452 years.*

With regard to multiple systems, there is a remark-

* Guillemin.

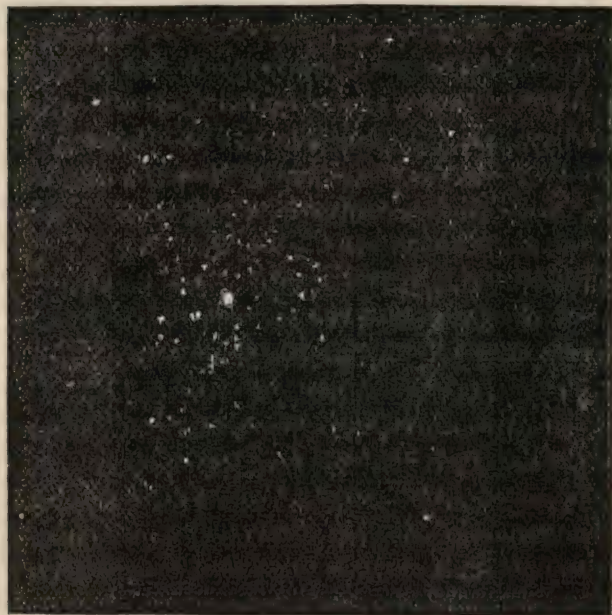
able one in the great nebulae of Orion, near the centre of it, and which is quite and easily visible to a moderate telescope. It is called the trapezium of Orion, and according to Humboldt, consists of six stars, making a *sextuple system*; but Mr. Lassell has since discovered a *seventh star* in this remarkable group, which makes it a *septuple system*,—or a real system of seven suns physically connected with each other and having the same proper motion.



Quadruple System of Revolving Suns in Lyra.

There is another group of four, or a quadruple system, in the constellation of the Harp or Lyre, which is even more remarkable for the peculiar arrangements displayed in it. Here are to be found four suns, arranged in pairs of *two*; the components of the first pair revolving round each other in about *one thousand years*, those of the second pair in about *two thousand*; while *one pair* revolves about the *other pair* in a period which, determined roughly from their distance, has

been computed to be not much less than a million of years. Ascending still higher, we go to the Pleiades, where *analogy* leads us to the supposition of a similar physical connection. Nor are we deceived; and recent observations have proved that the same laws are at work in this beautiful group of suns, and that among



Pleiades.

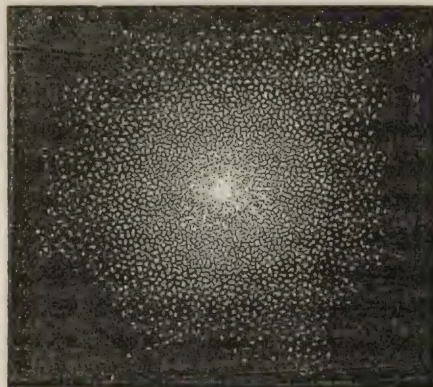
the seven visible to the naked eye, or the fourteen up to *hundreds* in the telescope, the proper motion of several has been observed, and an analogous conclusion received as the result, that here too is a system of suns physically connected, and revolving in mutual dependence upon and round each other, and probably all round the grand

and brilliant centre, Alcyone,—so conspicuous in that celebrated cluster, and so remarkable as the speculative central sun of Mædler, the pivot on which the solar system to which we belong has been said by him to turn. What magnificence and variety, then, do the unfathomable depths of space here unfold! In our own case we have a single sun surrounded by above 100 planets, and comets innumerable, all performing their appointed orbits with the most perfect harmony and wonderful precision, and deriving from one central luminary their life and light.

But far away in the depth of space scenes are revealed to us which reduce our entire system, magnificent as it is, to a *point in magnitude*, and, as regards illumination, to comparative obscurity. Here in these distant systems, millions of suns pour their unceasing splendid floods of golden light upon worlds unknown to us, and too diminutive to be perceived. Here planets receive the light of *two, four, six, or a hundred* suns in *succession*, many of them *coloured* with all the hues of the rainbow, while trains of planets like our own, wind their solemn way amidst shining archipelagoes of light, and myriads upon myriads of *systems sweep round other systems* with an *order and precision of arrangement* that never fails, but never permits us to imagine for a moment what some men erroneously suppose,—a dread catastrophe of world clashing with world, or sun with sun; but, on the contrary, that assuredly every globe in the heavens knows its own appointed place, and pursues its own appointed course without the possibility of celestial collisional ruin.

The light and glory of some of the closely-packed

clusters that are to be found in some districts, where, towards the centre, sun appears to melt into sun,—can scarcely be imagined, and affords food for the wildest dream of glory and heavenly splendour that the human mind can realize. “To be actually introduced, for instance, to a cluster such as that in Perseus* or in Hercules, in both of which the condensation of stars towards the centre becomes one blaze of glory, would be perhaps more than our present mortal nature and



Cluster in Hercules.

eyesight could bear.” Our present position, compared to it, would be darkness, or at best *feeble twilight*. On our entrance *there*, on every side of us, we should behold the blaze of hundreds of suns, many of them of varied colour, as in a cluster called Toucaine, in the region near the Magellanic Cloud in the southern sky,

* The cluster in Perseus is one of the most glorious objects in the heavens. It can be seen with the naked eye on a clear night as a faint white object in the Milky Way, between the bright stars in Cassiopea and Perseus. A small hand telescope will resolve it; but a 6-inch, or even a 4-inch, telescope will reveal a scene which few can behold without an exclamation of wonder and admiration.

where the central part is rose colour, with a white concentric border; or another, surrounding Kappel in the Southern Cross, which is formed of a number of white stars, interspersed with red, blue, and green stars, and appears to the eye as a white cluster. Many of such clusters, Herschel tells us, contain not less than 5,000 stars, collected into a space the apparent dimensions of which are scarcely the tenth part of the surface of the lunar disc. This however only tends to show the vast distance of some of these objects; for if the components of these suns are anything resembling our own sun or the stars which surround us (and there is no doubt of their perfect analogy and similarity), their real distance from each other, though it is probably not so great as that which separates the components of our own galaxy, yet must be far enough to free them from danger by collision from mutual attractions, and leave them space to move in their orbits around their common grand centre, whether that centre be composed of *one huge sun* or *of many*. We can readily imagine in such *combinations of suns* an agreeable difference of temperature from that in the unoccupied parts of the celestial spaces, where there is every reason to believe the lowest possible temperature exists; but in the case of crowded clusters and firmaments of suns and planets (many of which are revealed to the telescope, as already described), there is little reason to doubt that the temperature must be considerably raised; and not only so, but that many planets belonging to them must enjoy the powerful light of a never-ending day, such as St. John describes, in the heavenly city, who says “there shall be no night there.”

Here perhaps we obtain a glimpse of the glory of

some of those many mansions, or habitations, which Christ has gone before to prepare for His people. In those distant realms of creation, scenes of surpassing loveliness may be witnessed even now, by many of those whom we have known on earth, and who have departed to be with Christ, "which is far better," and which it would be vain to attempt to realize. Combinations of matchless beauty and repetitions of far more than the highest terrestrial glory, will pass before their eyes and wrap the senses of those happy people, to whom it was said while on earth, "Eye hath not seen nor ear heard, nor hath it entered into the heart of man to conceive that which God has prepared for them that love Him."

CHAPTER IV.

THE STARS—CONTINUED.

BUT what of the actual physical condition of the stars and suns? Of this but little is known for certain. The spectroscope, it is true, assures us of the identity of the materials that compose our own sun and its companion stars; and the wonderful conclusion which that instrument reveals to us is the high probability, amounting to all but certainty, that our own sun is an incandescent mass of metal, either partially solid, or in a molten or fluid state, surrounded by an atmosphere of fiery vapour, the chief element of which is hydrogen gas, as shown in the analysis of what are called the red or rose-coloured prominences,* which have been the subject of so much contention, and recent examination at solar eclipses. The fumes of many other metals and gases, however, are likewise to be found, and are distributed in different quantities and proportions to the different stars; and to this is probably owing the difference of colour so perceptible,—“one star differing from another” in the glory of its colour as much as the glory of its brightness. But in general the same compounds are found to

* These remarkable objects were formerly seen at solar eclipses only; but can now, by an ingeniously constructed telescope, be seen at any time.

exist, in every star that has yet been analyzed by the spectroscope, as are found in our own sun. The metallic substances are chiefly calcium, sodium, magnesia, iron, nickel, copper, zinc, barium, and sometimes cobalt; while hydrogen is generally found in the largest proportions in the huge rose-coloured flames, which we see leaping forth from the body of our sun to the height of from 30,000 to 350,000 miles.

There are, it is true, some who, with Sir W. Herschel, still affirm that these vapours composing the photosphere are merely gaseous; and that the body of the sun, or nucleus, may be cool below. It would not indeed be easy to determine such a question positively; but so far as the evidence of the spectroscope is to be depended upon, the probabilities are strongly against such a supposition. One thing however can be affirmed for certain,—that in every star to which that wonderful instrument has been applied as yet, are found evidence of the existence of the very same metals and gases that are to be found in our own luminary: nay, more, that the very same substances are found deep in the bosom of our own mother earth, and form not only the staple commodity of our planet, but of every star in the sky, and every other planet in our system, from the little aerolite, not bigger than a pistol ball, to the giants of our system that roll above us with their own attendant satellites. The sun therefore may be fairly considered *the type* of every *other star* in the heavens, as to the materials of which he is composed as well as his other conditions.

Now what are we to gather from this respecting the nature of those bodies that thus constitute the great element of the second heavens? or what proof have we

of this great fact? What positive evidence can be adduced to prove that the mere brilliant points of light with which the heavens are studded, and which the most powerful telescope cannot magnify or reduce to a disc to the human eye, are surely gigantic suns, the centres of other systems like our sun,—in all respects, except those of relative magnitude, the same. To an ignorant mind, the fact that each one of those twinkling lights is a globe of fire, or flaming metal, not less than a million of miles in diameter, appears so preposterous and absurd, that no reasoning is sufficient to convince an uneducated person; and the statements of astronomers are looked upon by many with a kind of half-faith, half-scepticism, that betrays itself in a lurking smile of incredulity while listening to their wonderful accounts of distance and magnitude. A very little reflection, however, and a slight amount of attention to the subject, or personal observation, will convince the most ignorant or unbelieving of the truth of the great and astounding facts revealed in the heavens on this subject. There are two matters in particular, relating to the stars, which *every one* should be enabled to understand, and as far as possible realize: viz., the vast size and distance of these bodies. Each of *these* quantities (if one be proved) would serve to prove the other. Given the magnitude, the distance would be concluded; or given the distance, and the magnitude would be apparent.

Now the actual and precise magnitude of a star could never be ascertained by mere observation of its appearance to the naked eye or in the telescope, from the circumstance that the most powerful telescope makes

no difference in the size of any fixed star which gives no real diameter, that which it seems to give being an optical illusion, which can be demonstrated; but as observations of a *planet* with a telescope we *know* perceptibly increases *its* magnitude, notwithstanding the vast distance of most of them, the inference of infinitely greater distance and consequent magnitude in the case of the fixed stars may fairly be assumed. Even by mere telescopic observation, that which undergoes *no change* of *size*, but defies it, under any telescopic power, must plainly be beyond the reach of ocular or optical power; and, whatever they are, must be classed as objects of inconceivable remoteness, and consequent magnitude. But though no real disc of any star has ever been seen, modern science has achieved the grand result without seeing it; and the probable diameter, and *magnitude*, and *even weight* of distant stars, can now be all but demonstrated,—not to speak of their actual constitution, or materials of which they are composed, as revealed by the greater wonder of the spectroscope.

The first link in the chain of discovery respecting the stars was the aspect of *their enormous distance*, from whence their *magnitude* was thus *inferred*. And how was this *distance* ascertained, and what is the conclusion as to their magnitude? Their distance was revealed by what is called their parallax,—by which is meant their *apparent change of place* relatively to each other, caused by the motion of the earth in space in its annual orbit. The earth in its orbit (as is well known) changes its *place* from one point to another by a distance varying up to 180 millions of miles. Such a journey, it was calculated, should make a corresponding change in

the apparent distances of the stars from one another, were they within any reasonable distance, as is the case upon the earth. *Such changes* of place (as is known here upon the earth) are *great* and *rapid* and *perceptible* in proportion to our distance from terrestrial objects, such as rows of trees or masts of ships or chimneys of houses, which seem to change their places, and close up or open out as we move on, if they are ranged on either side of us,—those objects that are in *front only* not seeming to move or change, but remaining stationary.

Again: according as we are near or far from such objects will the *apparent change* be *greater* or *less*, *quicker* or *slower*; just as two trees on a *distant* hill-side will seem to change their position as we move on, more slowly than those two in the neighbouring field; or a steamer on the distant horizon will appear to move more slowly than when leaving the harbour. This *apparent change of place and actual motion* (caused either by the moving objects we look at when stationary ourselves, or by our own motion in reference to them when they are stationary) are *magnified by proximity*, and *lessened or diminished by distance*, until, in a terrestrial landscape, an object in the distance, though really moving swiftly, seems scarcely to move at all; while objects at hand appear to move rapidly, even when they are themselves motionless.

Now to transfer this to the celestial landscape where stars only are the objects. All alike were for a length of time perfectly insensible to either of *these tests*. Up to the last thirty years, everything relating to the stars remained apparently fixed (without *change or motion*.) The great distance traversed by the earth, in reference to those at either side of her, produced no

apparent change whatever in the relative distance of one to the other (measured by the earth's change of place), nor was the slightest proper motion discovered in any single star. They appeared to be as *nails* in the *firmament*:

"The floor of heaven thick inlaid with Patines of bright gold ;"

the only change observable in them being their different position or place in the heavens between their rising and setting,—a change produced (as was well known) by the revolution of the earth on its axis. The closest observation and the finest instruments were baffled ; and for about 5,000 years the idea was, that while the stars were fixed *immovably in the heavens*, neither their magnitude nor distance could be approached by the mind of man. Our readers need not be told that all this has been dissipated ; and not only the displacement of many stars by the earth's annual motion in her orbit has been positively ascertained, but their own "proper motion" has likewise been discovered : and, as the inevitable result, by mathematical calculation, the magnitude of many if not absolutely demonstrated, yet has been approximated to ; and the distance if not possible to conceive, has yet been actually measured. The two keys, *parallax* and "*proper motion*," to which may be added the discoveries by the spectroscope, have opened the door of this long-concealed mystery, and let in a flood of glory. And what a view of the universe we obtain by it ! Take some of the principal stars that have been submitted to the searching analysis required,—an analysis which (in its particular details of calculation) could not well be made intelligible to any but a mathematician, nor be suitable to a popular explanation like this ; but which exhibits the following wonderful *results* :—

First, with reference to *their distance*.

While it would be difficult to ascertain positively the *actual* distance of bodies so remote, it can certainly be affirmed that the nearest of them cannot be less than twenty millions of millions of miles from the earth. Taking the parallax of the nearest fixed star (A. Centauri) at one second by direct measurement (adopting as the base line the diameter of the earth's orbit, which is 192 millions of miles), it can be demonstrated that the distance of such a star cannot be less than one hundred thousand times 192 millions of miles. Of such a distance we can form no adequate conception : before it, indeed, the entire diameter of the earth's orbit would dwindle into an imperceptible point. The only measure we can adopt to help us in forming a notion of it is light, the swiftest messenger we know of. Light travels from the sun in eight minutes, moving at the rate of 192 thousand miles in a second.* To travel such a distance then, it would take light about three and a half years to reach the earth from this star (A. Centauri.) Curiously enough a more distant star than this was the first point of the discovery the parallax of which was obtained by Bessel, who in 1838 announced the parallax of A. Cygni, in the constellation of the Swan, and which amounted to but one third of a second. This discovery, which was hailed as one of the most important features of the age in the annals of astronomy, was soon followed by the parallax and consequent approximation to the distances of several

* It has more recently been ascertained that this is an over estimate ; more careful analysis has reduced the rate of light to 184 thousand miles in a second : but the old supposition will answer the purpose as a rule of measurement of distance by time.

others, amounting however to a limited number as yet. The principal of these have been measured with as much precision as possible, and amount to eight,* seven of which are here given. Beginning with the nearest to the most distant, they are as follows,—taking as a *rule* or *measuring-line*, be it remembered, for expressing their distance, one of the radii, or *semi-diameter* of the earth's orbit, amounting to ninety-six millions of miles :—

	Radii.	No. of years reaching the earth.	
Alpha Centauri (nearest star)	211,330	3	6
61 Cygni (Bessel) - -	550,920	9	4
Vega - - - - -	1,330,700	21	0
Sirius (Dog Star) - -	1,375,000	22	0
Ursa Major (Great Bear) -	1,550,800	26	0
Pole Star - - - -	3,078,600	50	0
Capella - - - - -	4,484,000	72	0

The distances here enumerated are so enormous as to be perfectly inconceivable to the mind ; but perhaps not more inconceivable than the swiftness of the swift messenger we have used for our purpose. Take a *less* measure than the semi-diameter of the entire orbit for a rule or measuring-rod, and a slower messenger than light to traverse the awful gulf between us and the nearest of those shining bodies, and the *figures* in the one case and the *years* in the other will be necessarily multiplied.

Many such illustrations of distance may be used, and are used popularly, such as a cannon-ball, or a railway carriage ; but all will equally fall short of conveying to the mind anything more than *the general idea* of the abyss to be crossed to reach the nearest of the stars,—

* Guillemin and Lockyer.

an abyss which if our sun, with a diameter of 850,000 miles, was removed from us, and placed at the other side of it, where Alpha Cygni or Centauri now shine, would appear but as a star of second magnitude, far inferior indeed to the former, not by half so bright as they shine to us ; while our little planet, and all the other members of our solar family (giants, as we are in our own sight), at such a distance would disappear from the heavens and from human sight altogether.

Highly therefore as we may think of ourselves and the importance of our little globe, be it remembered we are for ever hid from the gaze of millions upon millions of planetary worlds that belong to those distant and countless fires of suns that are blazing around us each night, and whose planetary satellites are equally hid from our view for the same reason. As to the magnitude of these bodies, there is doubtless a great variety, as there is in their distance, their brightness, and their colour.

There are three modes by which the magnitude of a star may be determined, or at least approximated to : viz.,—firstly, *their relative brightness* or *apparent size*, by which they are called in astronomical catalogues, stars of first, second, or third magnitude, up to the telescopic stars, only visible to the telescope, which reach the thirteenth magnitude ; and secondly, by their distance as computed by *parallax* ; and thirdly, their proper motion. Although the first mode (their brightness) cannot be considered as so certain a test as the other, yet much may be gathered from it as to the probable magnitude of many stars, from this source alone. Mr. Procter, one of the ablest of our astronomers and accomplished of writers (in a recent

work* which cannot be too highly or deservedly praised), has given some astounding calculations from this source ; and has deduced, from a comparison of the relative light of different stars, conclusions respecting both their magnitude and distance, which are not only deeply interesting and important, but throw a flood of glory upon those distant regions inconceivable, and those shining points, before which our own little sun and his comparatively minute system pales and dwindles into comparative obscurity and insignificant and liliputian dimensions. In doing so, Mr. Procter boldly, it is true, but I think rightly, confutes what he conceives to be the popular but erroneous theory,—the uniform arrangement of the stars in the heavens, as first conjectured ; and the conclusion following from it,—that the *nearest* were necessarily the largest and the brightest, or the largest and brightest the nearest. It is plain that the brightness of a star might be due to three different causes : first, to its own greater intensity of brightness, such as may be seen by comparing the electric light with any other, even the most powerful lights, and which would thus overcome the effect of the most powerful of other lights as well as distance ; secondly, its real superior *magnitude*, which would have the same effect even though it were less bright ; or thirdly, its greater proximity to the earth, which would make it *appear* large and bright,—brighter and larger than many that are really superior to it in magnitude, simply from its proximity.

All these circumstances stood in the way of astronomers, as difficulties in determining the magnitude of

* "Other Worlds than Ours."

any star by its apparent size and brightness, *so long as the distance was an unknown quantity*. It was impossible to say, while this was unknown, to what that apparent size and brightness was owing, unless *proximity*. The recent discoveries of parallax have, however, overturned every theory which would make the relative brightness and apparent size of a star a certain test or proof of its real magnitude or distance ; the fact revealed by parallax showing us some of the largest and brightest actually the most distant, as in the case of Sirius : while some of the second or third magnitude, reduced by distance, are yet to be numbered among stars of the first magnitude. The difference in the size or magnitude of stars, as deduced by their *light* also, presents one of the most wonderful considerations science has ever revealed to the mind. Not only does it reveal to us *light itself*, or *brilliancy*, as a quality of infinite *variety* and *intensity* in these suns, but reveals these suns themselves of an *infinite variety* of *magnitude* and *distance*. There is therefore *no uniformity to be found in the heavens in these particulars* : differently *distributed*, then *differently lighted* ; of *every possible magnitude*, from a small *sun* not half the size of ours to one fifteen times the size ; from a volume of light and a flood of glory, exceeding that of our sun by 2,680 times, to others of lesser and fainter beams, not equal to a quarter in volume of that which we receive from suns whose magnitude equals that of *ours*, to certain diminutive ones not larger than some of our planets, and *these* of *varied* colours ; the two unchangeable qualities only remaining : *e.g.*, spherical *shape* and *matter* ; though in the latter (as the spectroscope informs us) even the matter is frequently differently distributed.

But let us hear from Mr. Procter how such a calculation can be made, and with what amount of *probability* can such conclusions be arrived at, from the consideration of relative brightness of the stars alone. In order to judge of the probable magnitude or diameter of a star from this source, it is necessary first to have a rough idea (as already mentioned) of its *distance*. This may be ascertained through the medium of its parallax, or apparent change of place, produced by the earth's annual motion. The problem may be thus solved: assuming that the *light of the star* whose magnitude is to be ascertained is the same as that of our own sun, on these two conditions, let us select a star, "*A. Centauri*." This star is one of the brightest in the heavens, *Sirius* and *Canopus* only surpassing it in splendour. Its great brightness, combined with its greater parallax, or apparent change of place, induced astronomers to consider it one of the nearest to the earth that was known of. Its distance has nevertheless been roughly computed as twenty millions of millions of miles, or 230,000 times the distance that separates us from our sun.

But if our sun were to change places with Alpha Centauri, what would be the result? The light it would give, by the most careful analysis (not on Sir J. Herschel's estimate), would be *three* times less than we now receive from that star: in other words, A. Centauri emits three times as much light as our sun would; and therefore, so far as light is a test of magnitude, the diameter of A. Centauri would appear to exceed that of the sun in the proportion of seventeen to ten.* But Alpha Centauri

is only one, and not by any means the largest, of those grand central suns which present so striking an analogy to our own solar system.

The greater number of first magnitude stars are far more distant from us than Alpha Centauri; while their brilliancy is not only equal, but in some cases (as in the case of Canopus and Sirius) far greater. The brilliancy of the former exceeds greatly that of Alpha Centauri, being not less than three times as light; and yet its distance cannot be even approximated to, not the slightest parallax being as yet discoverable in it; while Sirius,—the parallax of which *has* been ascertained, and is not one fourth that of A. Centauri, indicating a distance four times greater than that star,—did it only emit the same quantity of light as A. Centauri, would at such a distance shine with but one sixteenth part of *that* star's lustre, and is yet in reality four times as *bright*, though four times the distance. "The real amount of light therefore which it emits," says Mr. Procter, "cannot be less than sixty-four times that of A. Centauri, and 192 times that of our own sun." So from this indication alone it may be held to exceed that of our sun in the proportion of fourteen to one,—an estimate which assigns to Sirius a diameter of twelve millions of miles, and a volume or magnitude 2,688 times *that of our sun*. Thus far does the relative brightness of the stars help us to the discovery of suns, and doubtless systems, far *grander than* our own (great as it is) suggests; and not only does our planet seem in diameter a spot or grain of dust in creation, but our huge sun becomes a mere spark in the firmament when compared with the grander and mightier blaze of the diamond-like lustre of Sirius.

* "Other Worlds than Ours." PROCTER.

But not only are there greater suns than ours to be discovered by this means, but, with that wonderful variety which is so perceptible in all nature and our own system, we shall find suns far inferior to our own in magnitude. Thus the same writer shows that in the case of the star 61 Cygni, which is a *double star*, and one of those binary systems already referred to, the distance of 61 Cygni is nearer to us than Sirius, and three times as far from us as A. Centauri. This star, or rather the two components which constitute it, when calculated in a similar manner, shows that the sum of their volumes is but *one third that of our own sun*; and the sum of their masses but one third that of our sun's mass. Here then, if brightness be any test of magnitude, we have an instance in these three stars of a great variety in size, among the great representatives of solar systems in the heavens; "and," as Mr. Procter justly observes, "these are but three cases out of the entire heavens (taken at random) as suited to furnish an example of that variety." But, after all, who can say what may be the extent of *magnitude* or *diminutiveness* that may exist among the *numberless stars that crowd infinity*? what limit need there be when we are able to detect such diversity in these three instances alone. Could any one say which is the largest sun in the universe, or which is the smallest?

The analysis of the *relative brightness of the stars* therefore, compared with their distance, opens to us a glimpse of that infinite variety of magnitude in the heavens, which is so perceptible in the world we inhabit, and which places no restriction or limit to the wildest dream of the imagination, as it wanders

through those endless regions. We are here but as an emmet on its hillock, or as an invisible animalcula in its drop of water, which to it is its universe. But were it capable of intelligence such as ours, and were it enabled to behold and contemplate us,—*our oceans, our mountains, our planet itself*,—and become sensible of its own *minuteness* and our *vastness*, it might feebly represent what we are called upon to believe respecting the superior magnitude and glory of other worlds and systems than our own, and the infinite variety perceptible in them.

But there is another mode by which the magnitude and consequent distance of the stars may be estimated, and that without the assistance of parallax or an analysis of their relative brightness. And the operation by which this is effected is no less strange and startling than it is certain: viz., by *weighing the stars*, and from their mass inferring their magnitude and fitness to be the centres of planetary orbits. An incredulous smile probably passes across the face of some readers as this meets their eye: yet it is nevertheless *a fact*. Stars can be weighed, and the bulk or mass of those gold and silver spots of light ascertained; from which may be deduced, or at least approximated to, their size or magnitude, and distance.

The means by which this has been done is the examination of their "*proper motion*;" by which is meant, *the actual motion of the star itself in the heavens*, as distinguished from its apparent motion or motions. It can be readily comprehended that a star may appear to move without really moving, just as railway carriages often appear to be moving while they are stationary, and the apparent motion is caused by our own movement. So in the heavens, there are many causes contributing to

the apparent motion of a star or stars, which require to be first *separated* from its own proper motion before the reality of the latter can be *detected*. And its detection is no easy *task*, though it *has been accomplished*; and its accomplishment has enabled the astronomer actually to *weigh the stars*, and as a consequence to compute at least an approximation to their magnitude.

The *apparent motions* to be separated from the true motion of the star or stars are principally three. First, that produced by parallax, or the apparent shifting of the star from its place in the heavens by the earth's change of place in its annual orbit, as already described. Secondly, that produced by the rotation of *the earth on its axis*, by which the stars change their place *en masse* in the heavens,—stars and constellations rising in the east, and traversing our hemisphere till they sink in the west. This is so evidently produced by our own rotation, that there is no difficulty in separating *this* apparent motion from the proper motion of the star itself. Constellations and stars seem thus to appear as they would were they really without the least motion. There is a third motion known already, from which the proper motion of the stars has to be extracted,—viz., the motion of our own central solar system in space,—by which the sun moves forward round an unknown centre at the rate of half a million of miles in a day, carrying of course all his satellites (including our planet) with him. This movement, which is quite perceptible, must not be confounded with parallax, or the change produced by the earth's own motion or change of place in her orbit,* and

* To compare great things with small, there is a familiar illustration of these two motions in what every one has seen sometimes: viz., a little

must be separated from what is called "proper motion" of the stars.

The discovery of this latter motion has already been referred to; therefore it will be unnecessary to say more about it. But assuming that it is the case, and the actual motion of one star round another, or of many round a common centre, is a demonstrated truth, we arrive from it at the wonderful conclusion that it is possible to weigh these distant objects, and thus ascertain their density and probable magnitude. And here the great Newtonian law of gravity is again our guide,—a law which is to be found pervading infinity, and prevailing in the most remote regions as well as in our own system. That law informs us of what we call the weight of a body, which is nothing else than the amount of gravitating power or attraction exercised by one body upon another, or the amount of force or attraction measured by two things: first, the mass of the respective bodies; secondly, the distance from each other. Thus the weight or gravi-

cluster of common house flies performing their playful gambols, and circuiting round one another in the air, while carried along in a railway carriage at forty or fifty miles an hour. It was often in my early days a subject of speculation to me how they maintained with such ease the two motions: viz., their own proper motion and that of the carriage. They were evidently not conscious of the latter, and had no effort to make to maintain it. This however is easily accounted for by the fact, that the air in the carriage being carried forward with it as much as the window or the cushions, consequently it requires no more effort on the part of the flies to keep pace with the railway in the air than if they were on the window. Their amusing gyrations are performed, just as fish might perform similar feats in a rapidly running stream, down which they are borne; but their movements serve for an apt illustration of the *proper motion* of our *planet* in its orbit, or all the planets, when compared with the motion of our *sun* and *solar system*, with which we personally (*i.e.*, the earth) have nothing to do, and are not responsible for it, being carried forward passively as the flies in the railway. An analogous case is to be found with the moon and the earth.

tation of a body in reference to another will be in the *proportion of its mass and its distance from it*. Thus used, the weight of the traditional apple of Sir Isaac Newton, or the velocity of any body falling from a height upon the earth, will be the proportional index to a body of *any size*, however great, such as the weight of the moon, or even the great sun himself, or one of his great satellite worlds, or the most distant star in the heavens,—a knowledge of the respective masses of the two bodies in question, with their distance from each other, measured by this well known, but not less wonderful, law of gravitation, that the power of gravity or attraction increases or diminishes in the ratio of the inverse square of the distance, will at once reveal the result, or what is *called weight*; but which is really but the amount of gravitating power exercised by one body over another. In the case of the sun's weight, for instance (the great principle of gravitation being discovered), it is a comparatively easy task to place that huge body, as it were, in a *scale* and *weigh it with the earth*: i.e., determine the relative masses of each by the amount of their mutual gravitating power over a *third body*. All that is necessary is, first to determine the space travelled by any heavy body (be it a stone or an apple, a bullet or a planet) to the surface of the earth in one second of time, starting from the same point in space. This will be the measure of the gravitating power of the *earth*, which is found to be (assuming the centre of the earth to be the seat of the power which places the falling body really at 4,000 miles from the centre of attraction, that distance being equal to the semi-diameter of the earth) *sixteen feet in one second* of

time. Now place any body within the *same distance* from the sun's centre or surface, and compare the distance travelled towards *him* in the same space of time (viz., one second), and the problem will be solved. If the *same distance* only is travelled in the *same time*, no matter what the size of the *falling body*, the respective weights and masses are the same; if not, the difference between the distances and time will be the measure of the difference of the attractive power of each. But what do we find in the case of the sun? how can we ascertain his gravitating power? The only means by which this can be done, as it cannot be literally accomplished with a stone or an apple, is to use the earth itself as the falling body; and then by calculations from what we know of the gravitating power of the sun *over* the earth, solve the problem, by comparison of it with the gravitating power of the earth, as already shown, over the falling body. The gravitating power of the sun over the earth, or that power of attraction by which the earth is retained by the sun in its orbit, is easily ascertained,—by a knowledge of its *velocity* in its orbit compared with its distance from its attracting centre. So far the comparison between the earth and the stone or apple, and the sun and the earth, becomes feasible; but some obstacles still remain to be overcome before the problem can be completely solved.

The earth, as it is situated in reference to the sun, is 23,984 times more distant from *its* centre of attraction than the falling body already referred to, as situated at but 4,000 miles from the *earth's centre*: in other words, the stone or apple let fall from a height to the surface of

the earth, and found to fall sixteen feet in one second of time. How then shall the proportional measurement be made? In order to do it it will be necessary, in the first instance, to bring the earth by calculation to within the same distance from the sun, as the other falling body was from the earth (viz., 4,000 miles), and calculate what would be the amount of gravitating power *then* exercised by that luminary,—measured, as in the former case, by the rate of the earth's fall towards its primary. This has been done; and it is found, by the application of the Newtonian law, that the earth, instead of travelling sixteen feet in a second, would travel “five millions, seven hundred and eight thousand, seven hundred and sixty-three feet,” or 1,075 miles, in that same second.

Here then we have before us distinctly the proportional attractive power of the two masses, the sun and the earth respectively, measured by the *rate* of their respective *falls in one second of time*; and here we have consequently the *rule of proportion*, or the *measure* or *index*, for calculating the amount of their *respective masses*. Comparing thus then the mass of the earth with the mass of the sun, we find that action of the *two masses* on a third body situated at the same distance from it, will be as much greater in the one case than the other, as is represented by the difference between *five millions seven hundred and eight thousand and sixty-three feet, and sixteen feet*. Dividing this greater number by the less, we find that sixteen is contained 355,000 times in it: in other words, that the mass of the sun, measured by its attractive power, cannot be less than 355,000 times that of the earth; or that if the sun were put in one scale, and 355,000 globes like the earth piled in the other, *then*

(but not till then) would *the beam* be *even*: in fact, it would take 355,000 globes of the same mass and density as the earth to balance the sun; and as the weight of the earth is ascertained in like manner, the actual weight of the sun can without difficulty be *expressed* in figures, measuring by *the ton weight*, but of course giving no conceivable idea to the mind.

The sun once weighed, the application to other bodies is not difficult. In the case of planets *with satellites*, the satellites are the measuring weight of their luminary too, or rather the gauge of weight; while in the case of the stars, the components of the binary systems answer the same purpose; and in the case of planets without satellites, such as Mars, the perturbation caused by other planets act as measurements of the power of their gravity and their consequent weight. How wonderful all this! * But in illustration of this principle the weight of some particular stars has been ascertained. A. Cygni (to which we have already referred) is one of them. Being a component, or being a binary system, it was carefully watched (says Mr. Procter), and their revolutions round each other, together with their distance from each other, and the period of their revolutions approximated to. The distance that separates them is about 40,506 millions of miles, or half as large again as

* Isaiah challenges mankind to what in *his* day was deemed an impossible task, and only to be done by the Creator, when he says (Is. xl. 12), “Who hath meted out the heavens with a span, and comprehended the dust of the earth in a measure, and weighed the mountains in *scales*, and the hills in a *balance*?” So true has been the prophecy of Daniel, that knowledge shall increase in the latter times, that *now* not only have these apparently impossible tasks been achieved, but the still more difficult operation of weighing the sun, stars, and planets.

the distance that separates Neptune from our sun. The period of revolution is 520 years, being three times as great as the period of Neptune. "Now we know that a *planet* placed at the same distance as that which separates the components of Alpha Cygni would occupy a much less period than 520 years in completing a revolution: in fact, its period would be about 300 years." Hence it follows that the *attractive powers*, and consequently the sums of the masses of these two components of A. Cygni, are less than the sun's mass; and taken together, their united weight would not amount to more than *one third of this sun's*. A similar conclusion is arrived at in the case of the star Alpha Centauri, to the components of which Mr. Hind assigns a revolution of eighty-one years, and a distance from each other exceeding the earth's distance from the sun about fifteen times; a planet similarly placed would not occupy more than sixty years in completing the same revolution: therefore the united mass of the components of this star, also, must be for the same reason considerably less than that of our sun; although some difference is implied in the condition of that star as regards the intensity of its light, which is far greater (as we have already shown) than that given out by our sun.

This latter circumstance, we may observe in passing, shows us that the brightness of a star is not always dependent upon its magnitude or mass. But the conclusion derivable from this mode of weighing the stars and determining their mass, reveals to us what by other means it would be impossible to discover,—*the vast size and ponderous nature* of the smallest of them; and thus without the possibility of even a glimpse at the real

diameter of a single star in the heavens, which would from their vast distance and intensity of light ever be an insurmountable difficulty, the ingenuity of man has enabled him (without any great stretch of imagination, and following the pattern of our own sun) from the deductions of science, to arrive at a near approximation to what it really is, or what is the actual size and bulk of many a *grand centre*, round which roll (as in our own case) hundreds of planetary worlds (many of which are probably inhabited like our own), fed by their light, and controlled by the same Marvellous Power which pervades creation, and a knowledge of which has thus revealed to us what otherwise would be really hidden from our gaze for ever,—their fitness to be the centres (which *they* are) of systems innumerable; and here what the telescope may have left undone, the spectroscope has completed, when it points to every star in the heavens, and says, as plainly as though an angel himself had told us, "*There* shine millions of other suns, but composed of the very same materials and constituents, which are to be found in each shining *orb*, as exist in your own *sun*, in your own *earth*."

Not only therefore is it true there is nothing *new* "UNDER the sun," but there is nothing new "IN the *sun*." One is but the repetition of the other: the only difference being "difference of glory," as described by St. Paul; difference of magnitude and mass and colour; difference of intensity of light; difference in the *extent* of gravitating power, by which the inhabited planetary worlds, that roll by millions round their thousand million suns, are swayed; difference likewise in the *number* of those satellite worlds; and difference in their asso-

ciation with other companion suns, given possibly to aid them in providing additional and successive floods of light and glory over the worlds they control; but alike as being the grand *representatives of the life and light* that exists and spreads through the most distant regions of *infinity*. These are however evidently not the fires of merely ethereal lights, without substance or mass, or use, but to shine; but ponderous material masses of glory, whose heat *warms*, whose light *cheers*, and whose *weight controls and regulates and keeps in their several places* alike the *comparatively* small system to which we belong, and the gigantic system where Sirius shines resplendent with a power of twelve million times the light and power of our sun; and holds in his grasp, doubtless, a proportionate number of worlds obedient to his sway.

Thus the proper motion of the stars enables us to form a conception of their *mass and magnitude*, notwithstanding their vast distance; and in displaying it, assigns no limit to either, any more than the magnitude of a single stone of a building would enable us to conclude the dimensions of the entire palace to which it belonged, or of other and grander stones in the building.

CHAPTER V.

THE PLANETS.

WE now approach the contemplation of a different class of bodies from those we have had chiefly under our consideration. Hitherto we have been wandering among the great centres of solar systems,—suns, or stars, and their combinations. We now direct our attention to the planetary worlds (for so we may term them) that revolve around their centres. The word *world* properly implies a *habitation*, such as our *own world* exhibits; and could not be applicable correctly to vast globes of fire, or incandescent metal. To these worlds we have already referred briefly, but only incidentally and indirectly,—assuming their existence for the purpose of explaining the place occupied by their primaries, or suns, in creation, as centres and sources of life and light and heat.

We now approach a different class of bodies, which claim a certain amount of sympathy from us, as being *fellow worlds* placed in analogous circumstances with our own; and doubtless some of them, at all events if we knew but all, claiming a deeper sympathy not only of matter but *mind*; and resembling the earth not only in being members of the same solar family of worlds,

but containing on the surface, if not precisely *human* beings, yet material creatures designed to inhabit them, possessing life and intelligence, and the power to derive enjoyment from both, in as great a degree, if not in a greater, than is realized in the habitation which is *our home*. Round our sun revolve eight such globes, of a magnitude sufficient to warrant a close and searching examination of them, and comparison with our world.

Besides these there are above 100 smaller bodies, most of them discovered within the last twenty years, to which the name Asteroids has been given, and the comparatively diminutive size of which, combined with their distance, renders an examination of them fruitless as to their planetary masses. Some of the planets exhibit miniature systems themselves, as in Jupiter and Saturn, having solid planetary bodies moving round them as their centre, as the moon does round us, and probably fulfilling the same conditions. Of these planetary satellites we know seventeen for certain, to which our own moon may be added. We have here a class of bodies that separate themselves *entirely* from any that we have been hitherto contemplating, and perform a different part in the universe. They are, in fact, the receptacles of life as well as light, not the givers: and their very *place in the heavens*, and their every movement therein,—their material envelopes,—all, when examined, convey to the mind the irresistible impression that they are, or are intended to be, *dwelling-places—habitations*—where life and probably intelligence would be found were it possible for us to visit them. This invests the examination of these bodies with peculiar and undying interest;

which though some may consider as an insoluble problem, has yet received within the last few years such additional light and confirmation from the researches of the spectroscope, such additional circumstantial evidence, as amount almost to a moral *certainly*, or the highest possible degree of probability.

Since the celebrated controversy upon the subject of a plurality of worlds, between Professor Whewell and the late Sir David Brewster, information has poured in from those distant worlds to us of so much more decisive a character than those two eminent and accomplished writers were possessed of, that had the former of them (Professor Whewell) been alive now, it is more than probable he would have retracted much that he has said against that grand and noble theory; or had the spectroscope been discovered before the book on "The Plurality of Worlds" was written, it never would have appeared in the form in which it still exists.

There are so many Astronomical works now published, descriptive of the astronomical phenomena of the planets and their movements in space, that it will be unnecessary to refer to those matters, unless in a popular manner. In contemplating them, therefore, I shall only bring before the minds of my readers such later particulars, as modern observation has made known, respecting their *physical condition*, as will enable us to judge of the probability of their being really *habitations* or *dwelling-places*; at least, so far as the telescope and the spectroscope has revealed it.

The evidence of the same grand truth, however, furnished by the theological or religious aspect of the question, I will consider afterwards. Let me then, in

the first instance, ask my readers to look here upon paper at what they could not see at one time in the heavens: viz., the *assemblage* of four of these planetary bodies as they exist in our system, in their proper positions, including our own earth. The first glance



at this diagram impresses us with design, and assures us that the earth we inhabit is only one of a family of similar globes analogous to ours, which revolve round their common centre, the sun; and which, though of different magnitudes, and even at different distances, yet own the same grand fiery centre as the controlling

power which regulates their movements and sustains their existence.

Whatever difference may exist in other particulars, yet in this they are the same: *i.e.*, the same light which shines on one, shines with more or less power on all; the same *heat* which warms one is imparted in greater or lesser quantities to *all*. Examining the grand but simple expedients which have been adopted to secure these two advantages, all which we enjoy in our own globe (*viz.*, rotation on our own axis and inclination to the sun), and perceiving the very same expedients have been adopted for the others, the general impression is irresistible at the first glance at a simple diagram of the solar system. All these bodies are similarly constituted; they are members of the same family; they are under circumstances perfectly analogous one to the other; they are, in fact, but *other earths*: and although this does not solve the question of their being *all* NOW inhabited fully, it at least marks the *general design* in a manner that cannot be contradicted.

The solar system contains, as already shown, but eight principal planets worthy of notice for their magnitude. Three of these approach each other and the earth in size sufficiently to entitle them to be looked upon as companion worlds: the other four are gigantic bodies, and though resembling our globe in many particulars, are in this respect separated from us by association. Our earth, which is the largest of the four smaller planets, being relatively so minute compared to the giants of the system, that were we removed to their neighbourhood we would make but a small satellite to them, and bear the same relation to them in magnitude

that our moon does to us, only one tenth less instead of one fourth.

Taking the planets then in the order in which they are found, beginning with that nearest to the sun, we approach *Mercury*, the most diminutive of them.

MERCURY

Is the smallest of the eight *principal* planets, inclusive of the Earth, which constitute the solar family of worlds.

The Asteroids, or minor planets, already referred to, above 120 of which have been discovered within the last twenty years, we shall consider hereafter.

Mercury is not more than one third larger than our moon, and considerably less than half the size of the earth. It is one of those called inferior planets; not on account of inferior magnitude, but because their orbits are within that of the earth,—between us and the sun; those which lie outside being termed superior planets, in like manner, from the position of their orbits.

The inferior planets are limited at present to two, Mercury and Venus, though a third is suspected to lie within the orbit of Mercury.* Mercury is so near the sun relatively to the earth (being only thirty-eight millions of miles from it), that he is constantly bathed in floods of solar glory; and probably partakes of more solar heat, in consequence, than would be agreeable to us. This however is by no means certain, as the actual climates of planets, or portions of planets, like the countries of our own globe, are not altogether dependent

* Vulcan, discovered by Lescarbault.

upon direct solar heat for their temperature, which is modified in various ways.

Mercury, at his distance from the earth, being so small a globe, and hidden from our view by the glare of the sun during the greater part of his orbit, is a most difficult object for observation; and few amateurs are successful in catching a glimpse of him, keeping, as he does, even at the most favourable moments, close to the terrestrial horizon, which requires a clear and uninterrupted horizontal view; while he is only seen there for a short interval, at sunset or sunrise, and appears consequently as though he oscillated from east to west. Observation of his physical condition is therefore most difficult. These obstacles however are of course overcome in the regular and perfect arrangements of public observatories; where perfection in instrumental and telescopic power, locality, and entire professional devotion to the work, ensures as much as is possible to be seen. But the result, so far as determining the question of Mercury's physical condition, and consequent fitness to be a habitation for material beings, is, nevertheless, not as satisfactory as may be imagined. Some markings, and what some have supposed to be mountains, have been seen; but a dense atmosphere seems to surround this small planet, which under ordinary circumstances baffles a close inspection of it during the short opportunities afforded for examining it. Being an inferior planet (*i.e.*, within the orbit of the earth) it has phases like the moon; which, were it not for its atmospheric covering, ought (as does our moon) to reveal something of its nature and surface at its termination or boundary of light and darkness. But this the strong illumi-

nation in which it exists prevents, unless an accidental glimpse of it. The truncation or blunting of its horn has been seen, it is true,—indicating, it is thought, mountain elevations; and also a slight roughness at the bounds of the termination or division of light and darkness; likewise the effect of twilight, indicating the existence of an atmosphere which the spectroscope pronounces of the same constitution as our own. All this (which is all that can be depended upon,—the observations of the past age by Schroeter and others, with comparatively imperfect instruments, not being considered now of much value) leads to the conclusion that Mercury is a world resembling *our own* in many *particulars*; but from telescopic observation not affording much information where to ground any conclusions as to its being *at present* inhabited: while, on the other hand, there is nothing either in its position or appearance to justify an opposite conclusion; its proximity to the sun, and consequent excessive heat, being capable of being modified by its atmosphere and many other circumstances of which we are not informed.

The days of Mercury (ascertained from spots on his surface) are believed to be (like its companion Venus) of the same length nearly as our own (*viz.*, twenty-four hours); but its year is only one fourth of ours, as Mercury accomplishes his revolution in one quarter of our year, or eighty-eight days, moving at the enormous rate of 100 miles a minute. The inclination of his axis has not been accurately determined. The length of his seasons, therefore, cannot be precisely ascertained; but they cannot be much longer than three weeks on an average.

As the orbit of Mercury is eccentric, his distance from the sun varying greatly (and accordingly, it may be presumed, the temperature of the planet in like manner), at his nearest distance Mercury receives more than ten times the light and heat from the sun that we do; and at his greatest distance, still above five times that of ours; and even then his disc is *four-and-a-half times* larger than he is seen from the earth,—an appearance which would be very terrible to beholders here. Collecting together the climatal and seasonal condition of Mercury caused by his position, it is plain his physical aspect does not at first suggest the idea of his being inhabited by beings resembling man; yet there is nothing to lead us to conclude that he is therefore *uninhabitable*. It was formerly considered that water would boil on the surface of Mercury from his proximity to the sun, and that even lead *would melt*; and therefore it was impossible that any living being could inhabit the planet. Such hasty conclusions however have not been realized by the researches of *modern astronomers*, any more than by a comparison with the climatal arrangements for different tribes of men on the earth; and what will suit *one race* of men will not suit *another*, as in the case of a Greenlander or an Esquimaux and a Hindoo, who could not change places not only with comfort, but with safety to life. Nevertheless there is no climate of *the earth*, it is believed, where *some race* could not live.

As regards the astronomical circumstances of the planet, owing to its locality, undoubtedly it *ought to be*, and certainly should be, a much hotter globe than the earth, or a tropical residence; perhaps (it could

hardly be otherwise), with a sun that is nearly five times as large, and gives out ten times the *heat* experienced at the hottest parts of our globe. If something did not modify it, indeed, the consequences would be inevitable,—no fluid *could* remain there; and one could as easily reside on a red-hot ball as in such a planet. But this *very circumstance* (as I take it) is the *strongest proof possible* that there is a *modifying* cause at work there for the purpose of cooling the climate. Taking his *existence there at all, as a member of the solar family, into consideration*, together with the other circumstances connected with his physical condition (his *seasons* and his *meteorology*), that there *is* in *some way*, which we cannot precisely point out, a modification of this tremendous heat,—varied, as it must be, now by his changing distance from the sun,* now by the dense cloudy envelope of atmosphere which surrounds him,—may fairly be concluded. How completely indeed the argument for *design*, which placed him where he is, would be annihilated by the contrary supposition, that Mercury is little better than a red-hot ball! Of what use would seasons, days, nights, and years, be to such a body? of what use an atmosphere? (our uninhabited moon has none, simply because she has no living population; but Mercury *has* a dense atmosphere.) No one can pretend either that Mercury is a *little sun*: we see plainly he *is not*,—no more a sun than we are. Why then should there not be some modifying causes at work to moderate the temperatures of at least *portions* of this planet; and preventing the effects which would therein follow his

* The orbit of Mercury is eccentric.

position, render him a habitable globe,—not perhaps for *man*, but for material beings; not necessarily salamanders either, but differing as much in their bodies and constitutions from terrestrial inhabitants as Africans and Negroes and other inhabitants of tropical climates differ from Europeans or Esquimaux? Many theories would suffice to effect this, in spite of Mercury's hot berth in creation; and some *observations* render it *more* than probable.

There are three modes, indeed, by which intense heat may be modified, or kept under, on the surface of a planet. First, by having a very *rare* atmosphere. The effect of this we experience here when on the top of high mountains, such as the Alps or Himalayas, where there is perpetual snow, and the solar heat has little or no effect; the reason of which is, that if the solar heat passes more readily through a rare medium and clear sky to the surface of the earth, as in the cases supposed, on the other hand, *for the same reason*, it passes away from the surface of the earth more quickly than when the air is dense or cloudy. This refers us at once to the planetary atmospheres, as being the great *regulators* of the *temperatures of all the planets*. The sun in all instances being only the fountain or supplier of heat, to any amount, the atmosphere collects and retains it, or dispenses it according to its constituents and the circumstances of the planet requiring these modifications.

Safely, with this principle, we may walk through all the planets (portions of them at least), and find pleasant habitations even for ourselves. But if we leave a margin for the different species and constitutions of the animal and vegetable life of the planetary worlds (which need

not necessarily be a *stereotype* of the *earth's*, any more than the fauna and flora of India are the stereotype of the Arctic regions, or Australia of other portions of our globe), it is quite conceivable therefore, and there is no difficulty in believing, that the atmosphere which we see with our eyes* has in it the power of rendering Mercury quite habitable. This is much more probable than that excessive heat is prevented by a rare atmosphere; for while there is no appearance of such rarity, even if it did prevail it would not have the effect of modifying the sun's rays *there* to the same extent as it does *here*: there would still remain such an amount of intense heat upon the bodies of its inhabitants (exposed as they would be to the direct uncovered solar rays) as would be insupportable and destructive to human life. It is much more probable, therefore, that Mercury is fully protected by a sufficiently dense covering of watery clouds, as to produce a moist, and somewhat warm, though not dangerously warm, climate.

Then there is a third mode by which the climates of all planets are regulated, as we know in our own case: viz., the inclination of the equator to the plane of its orbit. It is this inclination of our earth's axis to its plane that causes the pleasant variety of climate in our own globe,—different phases of climate sweeping alternately over each country, and causing more or less, except in some few parts, the variation named by the four seasons. This modifies and regulates the climate

* The atmosphere of Mercury is quite perceptible to observation; but its existence is beyond all doubt, by observation of the planet at its transit over the face of the sun, when a cloudy circle has been seen surrounding it, as I beheld it myself in May, 1842.

of the entire globe, which successively enjoys a change, to those who never leave the same place. But in other planets (such as Jupiter) it is not so, and would not be so in our case, but for the inclination of our axis.

Now, as regards Mercury, the inclination of its axis is unknown. It has been guessed at, but there is nothing certain ascertained; therefore the effect produced upon the Mercurial climate cannot be affirmed positively from this source. But Mr. Proctor says there is one possible circumstance connected with the axis of Mercury which might render the Polar regions quite habitable, even at the short distance he is from the sun; and even though his equatorial regions were a zone of fire, and uninhabitable from the intense heat. It would be this: the eccentricity of Mercury is known to be so great, that if his axis were adjusted so that what would be his winter season should take place when he is nearest the sun, then his winter would be so tempered as to make his wintry pole habitable; and *vice versa* for the southern pole, his summer taking place when that pole was furthest from the sun. Then in that case the habitable portions would be limited to the poles; and the equatorial regions would be uninhabitable to creatures like us, and would form a wall of fire between the two regions.* As however the real inclination of the axis of Mercury is unknown, such speculations are vain, save as showing a possibility.

As to the inhabitants (if any) in Mercury, various speculations have been made as to their probable size, —some maintaining that the smaller planets, such as

* PROCTOR. "Other Worlds than Ours."

Mercury, must necessarily contain pigmies; and others, the reverse,—giants. The mass and density of planets are considered generally to regulate muscular power; the measure of the muscular power which material beings should have, or be able to exercise, being according to the amount of the pressure they would be subjected to by the gravity of the planet upon which they were placed. But the mass and density of Mercury are not sufficiently known to determine such a question, if indeed it could be determined by such a test. It is true that the power of gravity in any planet, the mass and density of which has been ascertained, can be estimated; and when compared with the bulk of the bodies that are to move on its surface, and the muscular power of those bodies requisite, a rough mathematical guess may perhaps be arrived at, or an approximation to what would be the size and power of locomotion in a material being placed on the surface of any particular planet. And trying the experiment with man as the supposed standard of planetary populations, and accepting his general muscular power and size as the rule, it is found that while there are some members of our solar system where he could not move at all, such as Jupiter and Saturn, and the other superior planets beyond them, where he would be crushed to death by their greater gravity, in others he would not only move more freely, but his agility would surpass (though he were the heaviest man now on earth) the swiftest animal we know here,—rivalling the deer or the greyhound. And so it has been said of the inhabitants of Mercury, which, being only 3,000 miles in diameter, is believed to have a density not more than one sixth that of the earth.

A man therefore upon such a planet would be fifteen times lighter than he is here; and every pound weight would then be only equal to seven ounces. The difference that this would make in his power of motion can scarcely be conceived: *i.e.*, on the supposition that the nervous energy by which we are now able to jump or run remained the same, imagine what we could do with half our weight, by which we mean the power of terrestrial gravity, that makes it now impossible to jump more than about five feet perpendicular with our greatest effort, or to run faster than from ten to twelve miles an hour without great difficulty; "but in Mercury we could jump above fourteen feet in the air" (says Sir J. Herschel), "or beat a railway carriage going at twenty-five miles an hour."

How far such speculations are correct, however, may well be doubted; for other conditions, belonging both to the planet and to the being placed upon it, may in a moment overturn or reverse the theory, however plausible. Passing however from planet to planet, we may naturally suppose that, preserving our own identity, we *should* find ourselves in a very different condition in each as regards our powers of locomotion and activity. If this be the case, either the populations of each planet (all of which certainly have a different density or mass) would require a differently constituted body from ours, or a body capable of altering its own density: * *i.e.*,

* That this is not impossible we have an example in the case of the angels who have visited our planet, and doubtless came from their own habitations, where a different power of gravitation existed. Their arrival here and departure indicated an immediate and (to us) strange alteration of their own specific gravity. It is to no purpose to say that angels, being

if all were to move with exactly the same freedom as we do here, and if all are to be of the same stature, and alike in general bodily conformation, then different powers of the muscular system must be bestowed on each,—strengthened in some cases to muscles of iron for the larger planets, and weakened proportionately for the smaller. The stature or height or size of planetary inhabitants being quite a different question, it would therefore be impossible to decide by such a test whether there are giants in Jupiter and dwarfs in Mercury, or (as Mr. Proctor thinks) the reverse, stature or magnitude being after all but an imperfect index to muscular power; for although there is a *general proportion* here among the *human races*, it does not follow that such proportion is extended to other races of which we know nothing. And even here the proportion on which Mr. Proctor reasons has frequent exceptions. I have seen weak giants and powerful dwarfs: in fact, giants that could not carry a dwarf, and dwarfs that (so far as muscular power was concerned) could carry a giant. Size is therefore an uncertain index to muscular power or activity; but if a conjecture is to be formed without presumption, it is more in accordance with our prepossession to imagine a large race in the large planets and small men in the smaller.* But in truth there is no key to this perplexing matter; and it is more probable, on

spirits, are not subject to the laws of gravitation. They appeared here with solid bodies; they ate, and drank, and walked, and subjected themselves in every respect to the laws by which our material bodies are governed, while they remained here.

* A nation of pigmies has recently been discovered in central Africa by M. Schwenhurl, averaging only four feet six inches in stature. (Vide "Heart of Africa," by M. Schemfarl. 1874.)

the whole, that man, as he is upon earth, is the standard size and model of the intelligent and material beings inhabiting all worlds,—the adaptation resolving itself in reference to the respective masses of the planets into an increase or decrease of muscular power and energy. And the same may be said with regard to the question of light and heat, so differently distributed in the planetary worlds. An alteration in the structure of the eye will arrange the one; while the capability of adaptation to climate, such as we see here, will satisfy the other condition,—all extremes of climate being mitigated by the cloudy canopy which surrounds these worlds, or by the constitution and physiology of the bodies inhabiting them.

Mr. Proctor's theory of the proportion of muscular power to gravity is formed upon the grounds of our own experience, and is a purely arithmetical calculation, which *so far* is doubtless correct; but in doing so he seems to have forgotten (as he has excluded) the consideration of the *psychological* view of the matter, which in my mind is the true index to it after all: *i.e.*, as to the amount of it as regards the power of resisting gravitation. What is it that makes the great difference in muscular power? To this it may be replied by another question: What is it that gives the different degrees of power and energy perceptible in the exercise of our volitions or will? We know what the meaning of a determined or desperate man is,—a determined will; and we know what wonders of bodily strength such persons are capable of exerting. The weakest women have been endued with a supernatural strength of muscle when under the influence of powerful excitement; so

with lunatics, whose strength is proverbial, and quite disproportioned in many instances to mere muscular development;* so also in the case of running matches and leaping matches. The truth is, the spirit of man is the moving power of the nervous system, as surely as the steam is of the engine; and all *material* calculations of gravity fail when this is excluded.

The power of angels to overcome gravity is a matter of fact, as also our Lord, who even in his strictly human nature was enabled to resist it, not only when he ascended to heaven with the body he had *after his resurrection*, but when he walked upon the waters of the Lake of Galilee *with a body in every particular like our own*, and communicated in a moment the *same power* to his Apostle and companion, Peter,—*a man of flesh and blood like ourselves*.† The psychological view therefore, in my mind, goes far to solve the mystery of the inhabitability of worlds of differing mass, which would not affect a being with a body which required but the effort of the

* The writer was informed many years ago, by an eminent physician then at the head of his profession in Ireland, and a near relative of his own, of the case of a lady whom he attended, who was subject to temporary fits of insanity, and who was naturally of a weak and tender frame, and of a gentle and amiable disposition. Having a great regard for him, during her lucid intervals she used to employ herself in netting a silk purse for him; an employment requiring the most delicate manipulation. When the fit came upon her, not only was she unconscious of her former employment and condition, but, becoming most violent, she acquired a supernatural strength so great as to enable her (as witnessed on one occasion), in spite of all efforts to restrain her, to seize the fire-grate of the room by the bars, and with little apparent effort drag it from its place on the hearth to the middle of the room.

† In the instance of Peter walking upon the water, it is remarkable that his walking on the waves and subsequent sinking in them are both referred to mental phenomena, as the immediate cause: by *faith* he was enabled to walk on them, and through *fear* he began to *sink*.

will to adapt itself to any amount of gravity or pressure from the attractive powers of the planet; but it is more rational to conclude that each planet has its own inhabitants, whose powers, both spiritual and material, are specially adapted to the system on which they live.

VENUS.

HAVING shown the probability (which astronomy does) of Mercury being inhabited, notwithstanding his proximity to the sun, let us now draw near to *his* and *our* next neighbour in the heavens,—the most *beautiful*, but perhaps the most inaccessible of all the planets to human observation of her physical condition,—*Venus*. Being an inferior planet, *i.e.*, whose orbit is *within*, or inside the orbit of the earth, much that has been said of Mercury is applicable to her, which need not be repeated. Like Mercury, Venus lives in the constant glare of the sun. Like Mercury, she *appears* as though she oscillated between east and west, for the same reason,—her mid-day course being invisible, except by the help of an equatorial, which (finding her place in the heavens at any moment) enables us to trace her course in bright daylight. Like Mercury, her *identity* at the two periods was doubted by the ancients; and it was believed there were two stars, a morning and an evening *star*, Lucifer and Hesperus. The beauty and brilliancy of Venus is so remarkable that the most unobservant are struck by it. It is diamond-like in lustre; and when in *opposition*, or in quadrature at her greatest elongation, nothing can exceed her brilliancy, which is often seen to throw a strong *shadow*, like the moon.

Venus is considered to resemble the earth in her conditions, more than any of the planets: *i.e.*, as far as magnitude and locality in the solar system, and her periods of revolution and rotation, which in all particulars differ very little from those of the earth; and though (owing to her position so near the sun and within our orbit, together with the probably dense atmosphere but brilliant light) we know less of her physical condition than that of her outside companion Mars, and can certainly see less of her surface than any other; yet the analogy between Venus and the earth is more striking in many particulars than in any other planet in the heavens. If *any* planet in our system is inhabited, I think it is probable *Venus* is; not from what the *telescope* reveals to us, but what her astronomical position and movements make known to us now. As regards her *position* and *magnitude*, days and seasons and years, she may be considered as the twin-sister to the earth: there are no pair of planets, indeed, that resemble each other so closely in the entire solar system,—the only exceptional feature being the absence of a *moon*, and a greater degree of light and heat. The former supposition however has not been ascertained beyond all possibility of doubt; more than half-a-dozen observers, and some of the most eminent astronomers, having *seen*, or thought they saw, such an appendage. Among these are Short (of telescopic celebrity), Cassini and Montaigne, Baudin, Rödkier, Montham, and Schröeter. Thus Italians, Danes, and French, and at least one eminent Englishman, unite in their testimonies as having seen this mysterious body, which Baudin measured and declared to be 2,000 miles in diameter (about the size of our own moon);

and Schröeter declares having seen it distinctly, accompanying Venus as a *black spot* across the sun, at the transit of Venus, in 1761. Admiral Smyth and Mr. Hind accordingly think the question of a satellite, or moon, to Venus an open question, not yet *decided*, and full of interest. Yet besides the fact that most of those who thus give their testimony lived in times when telescopes were far inferior to those of the present day, and that the combined power of modern research with the best instruments that man could make has failed to discern a trace of a moon, it is more than probable that Venus is moonless; or if she is possessed of such an appendage, it is so minute, and plunged so in the intense glare of that sunlit region in which she moves, as to defy discovery by human optics.

There is however but a slight deviation from the general resemblance of the planet to the earth in other particulars. Supposing that it is *certain* Venus has no moon, moving as she does in a region of space where constant and intense light prevails, both from the increased magnitude of the sun, which at Venus would appear fully one third larger than it would as seen from the earth, and consequently give out a proportioned quantity of additional light, as indeed is evident from the brilliancy of the planet itself; besides this, it is highly probable that the region in which Venus is placed is constantly surrounded by meteoric showers, revolving round our great luminary; and whatever be the nature of the mysterious nebulous ring of light,* the orbit of which extends from the sun, sometimes even beyond

* The Zodiacal light.

the orbit of the earth, and is always to be found within it, Venus must, as much as Mercury, be plunged in the midst of it, participating in it; while on either side of her lie what would amply compensate for the loss of *lesser light*: viz., *Mercury*, and the *earth* (with *her* moon), both of which would be visible to the inhabitants of Venus as splendid objects,—the former appearing quite as brilliant an object as Venus herself is to us; while the earth would shine more brightly than Jupiter, and our moon would be distinctly visible. As far as the partial illumination derivable from a moon like ours is concerned, a satellite would be *unnecessary* to Venus; and indeed the chief object of our moon does not appear to be so much for the purpose of lighting the earth as for regulating the tides of our oceans,* the distance of the earth from the sun requiring a supplemental power to raise *a sufficient tidal wave here*. The proximity of Venus to the sun, however, would render such assistance *unnecessary*; and the exact calculations of astronomers show that (assuming the existence of oceans like ours in Venus) the sun alone, at the distance she is placed from him, would be sufficient (in consequence of her nearer approach to him, and consequent increase of his gravity) to raise, without the assistance of any moon, tides exactly corresponding to those which sun and moon combined raise upon the earth.

The magnitude of Venus is nearly the same as the earth, its diameter being eight thousand one hundred and ten miles,—or wanting only the fifteen-thousandth

part of the diameter of the earth. This difference is so slight that were it possible for us to see the two globes side by side, it would be difficult to perceive any difference. Its mass and density also is so nearly that of the earth as to make but little difference in the power of gravity on the surface. It is possible, therefore, to imagine a fauna and flora closely resembling those of the earth, on this ground.

The mean distance of Venus from the sun is 68 million 932 thousand miles,—being one third nearer his surface than the earth. However, as the orbits of all the planets are not circular but oval, this distance varies about a million of miles at times; but this is a trifling distance in celestial measurement, and would make little or no difference in the amount of light and heat imparted to the planet, while the difference of her orbit from that of a perfect circle, if described on paper, notwithstanding its really elliptic form, would be imperceptible. Of all the planets the orbit of Venus deviates the least from a circle, by which movement a greater uniformity of light and heat will be sustained. With regard to her distance from the *earth* there is a much greater variation, depending upon the relative position of the two planets. When on *our side* of the *sun*, or in *inferior conjunction*, as it is called, Venus and the earth are only a little more than *twenty-four millions of miles* apart; but when Venus is on the opposite side of the sun, or in superior conjunction, her distance from us is increased to 166 millions of miles. This of course reduces the size of the planet proportionately, but not the distinctness of vision, as she is a better object for the telescope at the greater distance,

* Vide "The Lunar World," by Rev. J. Crampton. Edinburgh: A. and C. Black and Co.

in many respects, than when near to us at inferior conjunction. The best time, however, for viewing Venus is at her quadrature, or elongation at either side of the sun, or at the position of her orbit intervening between them.

The length of Venus' year is 224 terrestrial days and seventeen hours (nearly), or a little more than seven months: her day, or revolution on her axis, is like our's,—twenty-three hours and twenty-six minutes, or about half-an-hour shorter than the earth's. Supposing that the seasons of Venus correspond to those of the earth,—*i.e.*, that her polar axis is at the same angle as the earth to the plane of her orbit,—her climate, notwithstanding the greater amount of light and heat from the sun, would much resemble the earth's, and, like the earth, she would have her tropical regions and her temperate zone, arctic and antarctic, while the apparently more dense covering of atmosphere and clouds, the constituents of which have been pronounced by the spectroscopic analysis to be similar to the terrestrial atmosphere, would help to modify any extremes that might otherwise be produced by solar heat. The constant light in which she is placed, too, with probably beautiful auroras and other electric phenomena to a much greater extent than at our distance from the sun, would render Venus a suitable and splendid habitation for inhabitants constituted like ourselves. The real climate of Venus, however, according to the calculations of many astronomers, does not resemble that of the earth as nearly as we have been supposing, if the inclination of her axis to the plane of her orbit is as great as it is believed to be by some: *viz.*, from 55°

to 75°. Even the former, which is the result of De Vico's observations, and thought to be the most probable would produce, unless modified by atmosphere and other causes, a climate of such violent extremes of heat and cold as would render it uninhabitable to beings like us. The consequence of such an adjustment of her axis would be (says Mr. Proctor) that the arctic regions would extend to within fifteen degrees of her equator, "while the tropics would extend to within fifteen degrees of her poles; thus giving two zones larger by far than the temperate zones of our earth, belonging both to her arctic and her tropical regions. And it would be difficult to say whether her polar, or her arctico-tropical region would be to our ideas the least pleasing portion of her globe." The extremes of heat and cold would be such, under such peculiar "circumstances, that none of the human races could bear the alternation between her polar terrors, and an intensity of summer heat far exceeding anything with which we are familiar on earth, and which would suffice to destroy nearly every race of human beings subsisting now upon the earth." *

Besides, however, that much uncertainty still rests upon the observations that are necessary to decide positively the inclination of the axis of Venus, we need have little doubt that, even if it does differ from that of the earth to the extent which has been affirmed, other and compensating causes and circumstances are at work, and can easily be conceived, in the nature and regulation of her climate by her atmosphere, as to render her climate, although differently distributed, quite

* "Other Worlds than Ours." PROCTOR.

as habitable as the earth. Before leaving the subject of the influence of planetary atmospheres upon the climate of planets, I may mention that the calculations of Mr. Williams* respecting the density of the atmosphere of Venus, upon the theory of the existence of a universal atmosphere of similar composition to that of the earth, and accumulating round every gravitating body of the universe in a quantity proportionate to its gravitating power, gives as the result an atmosphere resembling as nearly as possible that of the earth in density, and producing a climate according with that supposed already as the result of astronomical and telescopic observation. Mr. Williams thus describes his theoretical analysis of the atmosphere and climate of Venus;—

“The mass and dimension of the planet Venus approximate so closely to that of the earth that the density of its atmosphere should only differ from ours by so small a fraction that we may consider it as about the same. The only important meteorological differences between Venus and the earth would be those due to its greater proximity to the sun, and the greater inclination of the plane of its equator to its orbit.

“In the first place, there *should be* land and water as upon the earth; but, as the quantity of heat received by Venus from the sun is nearly double that which comes to the earth, the atmosphere *should be* loaded with aqueous vapour. This, again, would moderate the action of the sun upon the surface of the planet itself, as the vapour would absorb so much of the planet's heat and retain it in the atmosphere. So far, we should have the conditions of a *hot, humid*, and equatorial climate, as compared with that of the earth; but then, the inclination of the axis, producing such extreme variations between the summer and winter, exposure to the sun, the temperature, and polar regions, would seriously disturb this

* “Fuel of the Sun.”

equalizing influence of the aqueous vapour. Thus, there *would be* great extremes of evaporation and condensation. And Venus *should be* a *foggy, cloudy*, and *rainy* planet, with some polar snow during the winter, and probably polar glaciers: its atmosphere thus charged with vapours, and perhaps augmented in density by them, *should be* easily detected; but its surface configuration would be much obscured by the misty envelope.

“This *theoretical* sketch,” says Mr. Williams, “which is merely a statement of what *must* result if my hypotheses are correct, corresponds as nearly as possible with the conclusions arrived at by actual observation, as the following quotations will show, from Guillemin's work on the Heavens, edited by Lockyer:—‘If we refer,’ says Guillemin, ‘to the drawings of Schroeter, which represent Venus in three of its phases, we shall notice that the luminous part of the disc is far from terminating abruptly along the line of shade; its light, on the contrary, diminishes gradually, and this diminution may be entirely explained by the twilight on the planet. The existence of an atmosphere of considerable height has been inferred, which, by reflecting the rays of the sun, enables them to penetrate into the regions where that body is already set.’ Thus the evenings of Venus would be like ours, lighted by twilight, and the mornings by the dawn. In summing up generally the results of various observations, Mr. Guillemin says: ‘*Perhaps a very dense, cloudy atmosphere, constantly charged with vapour arising from the heat, envelopes the globe of Venus, and thus moderates the rigour of its opposite seasons.*’”

A fact which gives this hypothesis confirmation is the observation of a transit of Venus over the sun in 1761. A nebulous ring seemed to surround the black disc of the body; and, moreover, at the moment when it was but partly projected on the sun, the contour of the exterior limb of the planet was seen edged with a luminous ring.

The cloudiness and consequent climate of the planet is

further indicated by the markings on its surface, so far as any dependence can be placed upon them; but Lockyer, and other English astronomers, with telescopes of the best construction, have failed, in this country at least, to verify the statements of the older observers of other climes. Among these, Italian astronomers are conspicuous, which, perhaps, serves as a key to the reason why they, with inferior telescopes, were enabled to see what could not be discerned here. The indistinctness produced by our own misty climate and atmosphere preventing the full action of the best telescope, far more than the cloudy envelope of Venus, and rendering an inferior telescope, in a dry and *clear atmosphere, more effectual* than the best that human hands could make under a British sky. However, the markings on the surface of Venus, seen by the Italian observers, Cassini, Baudin, and De Vico, and also by a French astronomer, Montaigne, and which agree in many particulars, could not have been *all delusions*. And though Mr. Lockyer thinks these are by no means borne out by modern investigation, and cautions his readers against receiving absolutely the inferences drawn from these old observers, yet, as the English observations as yet are only *negative*, and the *Italians positive*, it would be hardly prudent to attach no importance to these latter, and we may, without prejudice to the cause of truth or science,—confirmed, as many of them are, by agreement with each other, and also by one by Schröter (a close and accurate observer),—consider them as the best that have been made. Blanchini represents in his drawings two polar and two equatorial continents, the latter being more probably *seas*, being the darker portions.

The difficulty of distinct definitions however, even under the most favourable state of the heavens, is the strongest proof we could have of the real density and extent of the atmospheres. I have myself however seen, even through clouds and vapourous film, with a ten-feet common refractor of six inches aperture reduced to two inches, and frequently since with three and four-inch acromatics, the gradual shadowing of the termination betokening the twilight, also the bluntness of the Southern Horn; and on one occasion, with the large instrument just referred to, a distinct bright spot at the extreme end, and separated like an island of light from the Southern cusp. It reminded me of what is a common and familiar sight in the moon: *e.g.*, the top of a mountain tipped with sunlight. Speculations are varied as to the configuration of this to us mysterious but beautiful globe. Its mountains and vales and oceans must ever remain hidden from our mortal sight. Yet, looking at it, we may each let our imagination roam through fancied scenes of glory and beauty far exceeding our own beautiful earth; nor can the eye of the Christian astronomer behold it without the deepest interest,—not only as remembering that it is the Scriptural emblem of Him who is named the Bright and Morning Star, but as probably constituting one of those many mansions prepared by Him to receive His people; as one of those places with which death will possibly make us immediately acquainted, and the lustrous aspect of which to the eye is but the index to the nature of mysterious lands at present veiled from our sight, the real glory of which lie within her sphere; where possibly we may wing our way, and find

many we loved here and parted with on earth, walking in its abundant light, and enjoying in its lucid regions pleasures that never fade.

MARS.

MANY persons not usually very observant of the heavens have yet been somewhat alarmed by the sudden appearance of a large blood-red star, as large as the planet Jupiter, and which, not having been previously noticed when in the same position, has led them to think it is a strange object, and have looked at it with wonder and suspicion. On inquiry, however, as to its nature from anyone who is conversant with such matters, they will be told, to their astonishment, that it is only "the planet Mars" introducing himself to the notice of the world at his triennial visit, called technically by astronomers "The period of his opposition," when only he can be seen with advantage by those who are desirous of inspecting him, being magnified by his approach to the earth to more than double the size he appears at any other period.

The explanation of this is simple. The orbit of Mars lies far outside the earth, being separated from us by a mean distance of about 40 millions of miles when nearest to us: *i.e.*, when in the same part of the heavens as we are,—on our side of the sun and directly opposite to us,—so that a line drawn through the centre of Mars would pass through the centre of the earth, on to the sun. Mars then is in what is called "opposition," or at his nearest point to us. Did the two planets keep pace with each other from this point, the magnitude of Mars would always be the same, and he would appear as he

does at opposition *constantly*. But this is not the case, and as the earth, being nearer to the sun, travels much more swiftly, Mars is for a time left behind in the race, and the earth gradually widens her distance from him, during which time he gets smaller and smaller, until at length his greatest distance from us is accomplished: *viz.*, when both planets have arrived opposite to each other again, but at opposite sides of the sun. Then it is evident the distance which separates the two planets is increased by the entire diameter of the earth's orbit, added to the 50 millions of miles from which they were previously separated at the period of opposition. To illustrate this, let two persons represent, one the earth and the other Mars; let them stand at a round table,—he who represents the earth at say two yards from the table, and the representative of Mars one yard beyond him, and exactly behind him outside: this would be the case of Mars in opposition, separated from the earth by only one-third of *his* distance from the sun,—in round numbers, say 150 millions of miles. Now let the person who represents the earth move round to the opposite side of the table, preserving the same distance of two yards from it, and leaving him who represents Mars standing where he was: here would be a representation of Mars in conjunction, as it is called, or at his greatest distance from the earth. This would be, as could be seen, the *united distance* of the entire diameter of the earth's orbit added to the original 50 millions of miles,—or 200 millions plus fifty: *i.e.*, 250 millions of miles. It is easy to comprehend what a difference this must make in the apparent size of Mars at *opposition* and *conjunction*.

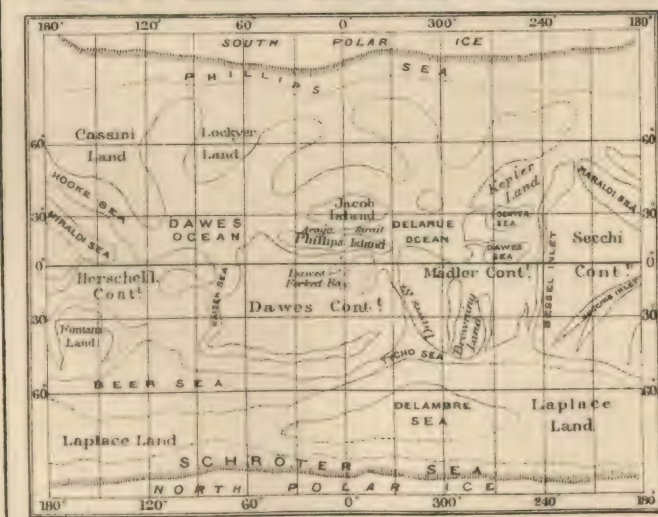
When he is at the former he is five times nearer and twice the size as at the latter, when he dwindles, from distance, into an insignificant red spark. There is besides this cause for the changes in the apparent size of Mars, another, which makes the discrepancy of size and distance greater even at times,—and that is the eccentricity of his *orbit* and that of the earth, neither of which it must be remembered are *perfect* circles, but *ovals* or *ellipses*, the centres of which are not to be found at the centre of the sun, but at a considerable distance from him. The effect of this will be to render at certain times the distance considerably greater as well as the approach of the planets to each other nearer. This cause, for instance, operates so as to make the greatest distance of Mars from the earth 256,000,000 of miles and his least distance from us only about 35,000,000, his disc being increased or diminished to our sight proportionately. The eccentricity of the orbit of Mars indeed is so great, *the centre of his orbit being thirteen millions of miles from the sun*, that the amount of light and heat received by him at his perhelion, or nearest approach to the sun, and his aphelion, or greatest distance, must differ in the proportion of *one half* at each *period*.

The physical aspect of this planet, however, is to us the most interesting feature; and though the time for observing him is limited, astronomers have been enabled to gather more from him as to his condition than any of the other planets; and presenting as he does so striking an analogy to our own globe, he is, if not always the most brilliant, the most interesting star in the heavens. Mars, indeed, is the only planet in the heavens the geographical features of which have been positively



J. N. ASMITH, D. C. L.

CHART OF MARS ON MERCATOR'S PROJECTION.



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ascertained and distinguished from the atmosphere that surrounds him, and which in the case of the other planets presents an all but impenetrable veil and obstruction to the discovery of their features and physical condition. Mars, though always presenting a full face to us so as to prevent us from seeing the contour of his mountains, as we do in the moon, yet has not prevented us from ascertaining the boundaries of his oceans and continents and islands, and probably forests and prairies, as well as his arctic and antarctic regions. These have not only been conjectured from transitory views, but recorded permanently, after years of observation, and mapped out on a scale as accurately, or even more accurately, than the boundaries of sea and land in our own globe.

These discoveries afford an instance of the highest achievement which the telescope has performed, or the human sight has been permitted to attain. Forty or fifty millions of miles, although it sounds but little in celestial measurement, is really an enormous distance, and quite inconceivable to us. If we could be transported to that planet, across the gulf that separates us, at the rate of twenty miles an hour without ceasing for a moment, it would occupy us 285 years in our journey. To be enabled to perceive distinctly the configuration of a globe at such a stupendous distance from us, and even to mark the very clouds that float in its atmosphere,—to watch the melting of his winter snows, and the falling of his icebergs,—is one of the strongest testimonies of the perfection of *instrumental* power, as well as of the triumph of intellect in the Being who devised such a giant's eye, or an angel's power of sight, to be enabled

to accomplish it, and to watch the changes and operations of nature in another and a distant world.

There is no other body in the heavens the actual physical details and geography of which have been seen and recorded but the moon; but our satellite, besides her proximity, is an uninteresting object compared to Mars, or any planet, and only affords us a picture of barren and dreadful sterility, such as a desert volcanic rock in the ocean would afford compared with a green and populous island in the Pacific; but in Mars we have a celestial island, every feature of which resembles our own planet, so that a feeling of intense curiosity and interest is excited by the examination of it with a telescope: under such inspection, indeed, great as his distance from us is, the impression of his habitability,—*i.e.*, his *present* habitability,—is powerfully suggested to the mind that contemplates it.

Mars is not more than half the magnitude of the earth, being only 4000 miles in diameter, or twice the size of the moon, forming what may be termed a miniature earth, yet not so small as not to form a most important member of the solar family, being situated at a mean distance of 144 millions of miles from the sun. He probably receives a little more than half the light and heat from him that we do, though this cannot be certain, at least as far as heat is concerned, as we have already shown in the case of Mercury, the exact modifying causes which are at work to regulate the temperature of the planets being unknown to us. His orbit, too, being eccentric, the proportion of light and heat received by Mars will vary immensely,—receiving but half the light and heat at his aphelion, or greatest

distance from the sun, that he does at his perihelion, or nearest approach.

The density of Mars is less than three-fourths that of the earth, or nearly four times that of water, which is generally used as the standard substance for measuring the density of the planets. The effect of this will be of course to lessen gravity at his surface, so that 1lb. weight on the earth would only weigh 6 ozs. 3 dwts. at Mars,* rendering locomotion an easy matter in such a world, as it was in the case of Mercury. The years of this planet are nearly equal to two of our terrestrial years, or 687 days; while his days are twenty-four hours and thirty-seven minutes. The inclination of his equator to the plane of his orbit is believed to be $27\frac{1}{4}$ degrees, differing only a little from that of the earth, which is $23\frac{1}{2}$; therefore, *from this cause alone*, the climates of the two planets will not be likely to differ much, though doubtless there are other conditions and circumstances relating to it which may render a considerable difference of climate probable. Mars is believed to be unaccompanied by a moon, and in this particular differs from the earth, and the general analogy of planets attended by satellites,—*i.e.*, if it be the case; but Dr. Lardner, and Dr. Dick, and others, contend for the possibility of the existence of a moon, though unseen by us owing to its diminutive size and proximity to the planet, if in due proportion as to its magnitude and distance: thus the second satellite of Jupiter is only the one forty-third part of the diameter of the planet, and a satellite that would be only the forty-third part of the diameter of

* Proctor.

Mars would be under a hundred miles in diameter. Such an object would scarcely be discerned even by powerful telescopes, especially if it did not reach far from the disc of the planet, the light of which would render it imperceptible; indeed, the fact that for many years one of the satellites of Saturn was undiscerned, renders it not altogether improbable that a satellite to Mars may yet be found.

The red colour of Mars is one of the features that is most remarkable, being so different from Venus or Mercury,—being indeed the only red planet in the solar system. There have been many conjectures as to the cause of this, but none altogether satisfactory. The redness indeed *partially* disappears under a close inspection with the telescope, but not completely; and it is thought to be owing to something in the soil or surface of the planet, rather than to his atmosphere, which latter some have imagined to be the cause. The telescopic survey of Mars has been the subject of astronomical research from an early period,—from Hooke, in 1666, up to the present time,—including the Herschels, Beer and Mœdler, Nasmyth, Jacob, De la Rue, Philips, Dawes, and Lockyèr, with a host of other eminent astronomers. There is no planet in the heavens indeed which has undergone so close a scrutiny, or which has rewarded the observer with more interesting results; and has enabled us to detect, at the enormous distance of forty millions of miles, an island world like our own, with its entire configuration,—even the green colour of its oceans or savannahs or forests, its polar ice and snows, even to the melting of that snow, or the fall of a shower of it, or the tumbling of a mountain iceberg into the Martial

sea, or the gradual raising from that sea of the frozen mists and clouds that hang over it, as in our own polar regions. All this, and much more that we shall relate, has been revealed to the wondering eyes of the inhabitants of the earth; and so clearly rendered visible that many charts of Mars have been made that excel those of the earth in accuracy of outline, and many interesting sketches: among the latter that represented in our plate may be considered one of the most interesting, taken by Mr. Nasmyth, in 1862, in his 14-inch reflecting telescope. It reveals not only the Polar or Arctic regions, with the ice-cliffs at the boundary, but the interesting feature of an island, in the midst of a Martial ocean, about the size of the British Islands.

Before Nasmyth, Sir William Herschel had charted Mars; likewise Beer and Mœdler. Professor Phillips too, and Mr. Lockyèr, had constructed two globes of Mars, presenting most of the features visible in the telescope. But the most elaborate and perfect delineation of the entire Martial country is that which has been made within the last three years, by the united efforts of Mr. Proctor and Mr. Browning, of the Minories, London, from twenty-seven admirable drawings of the planet by the late Mr. Dawes, the result of thirteen years close observation of the planet by that most eminent astronomer, and who was deservedly reputed to be one of the best observers in the kingdom. These drawings were entrusted to Mr. Proctor for the purpose of charting the planet, which he has done admirably, both stereoscopically and on Mercator's projection, to which plate our readers are referred, Mr. Proctor having kindly permitted the writer to copy it. Mr. Browning, the eminent optician, has

since constructed, from the drawings already referred to, a solid globe, containing all the features of the planet in their proper positions (from which several beautiful stereoscopes have been taken), by which the entire configuration of the strange country may be seen, as though the stereoscope had been taken directly from the planet itself. It is hard indeed to believe, when looking at them thus ingeniously produced, that they are not photographed from the planet itself directly, so perfect a globe does it appear; and indeed we have reason to believe, that a photograph from Mars (were it possible) would not be much more accurate than what we behold, which Mr. Proctor affirms to be a most correct transcript to the solid globe of Mr. Dawes' various sketches. A photograph from Mars itself directly never could be obtained, as the almost constant veil of cloud and mist that hangs on his surface, only occasionally rising, prevents the possibility of more than a partial and transient examination of his surface at one time. Unless indeed the entire Martial atmosphere altogether disappeared, a photograph would be impossible; and even if it did, the comparatively feeble light of the planet would be very unfavourable for a picture. To effect what has been done, therefore, required not only a keen sight (for which Mr. Dawes was remarkable) and a first-rate telescope, but indefatigable perseverance on the part of that able astronomer, to make out, after thirteen years' incessant watching, every separate feature of its surface, revealed only by occasional glimpses, and to distinguish the *permanent* markings from the *deceptive* ones caused by moving clouds: but these features being now put together on a solid globe, on a perfect scale, by

Mr. Browning and Mr. Proctor, enables us to see this remarkable globe as though a photograph had been taken from a cloudless planet such as the moon.

But although there *are* many matters relating to the planet, that can only be the subject of our speculation, yet many of the moving processes of nature absolutely in action can be discerned by us. Thus the annual contraction and extension of the snowy zones at the poles, by alternative melting and freezing, can be distinctly perceived, and have been measured. This indeed constitutes one of the most interesting features connected with the planet, as bearing a strong analogy to the circumstances of our own globe. We know the poles of the earth are ice-bound: the appearance therefore of a white circular patch at the poles of Mars led Sir William Herschel naturally to the conclusion that the white revealed there was snow and ice, as on the earth; and closer scrutiny revealed the highest probability of this fact by the partial annual or seasonal disappearance, or contraction and expansion of the outline or boundary of the snowy region in the Martial summers and winters. The familiar phenomena of melting or thawing and freezing, as on the earth, were naturally and irresistibly suggested and exhibited; also snowing, and its consequent disappearance. Accordingly these regions were carefully measured at the corresponding seasons, and found to diminish or increase on a regular scale in proportion to the advance or retreat of the summer rays. Thus the magnitude of the South Pole was found to diminish gradually from June 16th, 1830, to July 19th of the same year, from a diameter of $12^{\circ} 46'$ to $8^{\circ} 2'$. The following is the table of observed changes:—

June 16th (the period answering to that month in Mars),			
the diameter of the snowy spot was	-	12	46
June 23rd,	"	11	30
June 26th,	"	7	10
July 7th,	"	6	20
July 9th,	"	5	46
July 19th,	"	8	2

The rapid melting of the snow and ice will be here perceived, implying a reduction (in less than a month) of more than half the diameter; also the equally rapid increase on 10° from July 9th to the 19th. The border of the snow-zone on June 16th stretched to the latitude of $83^{\circ} 37'$; on the 9th of July only reached to $87^{\circ} 7'$ latitude. This was at the South Pole. The same result attended the observation of the North Polar spot,—the minimums of both taking place at the same time of the year, answering to the 12th of July, or the 12th of January on the earth.

The diminution of the extent of the polar snows was, however, found to be unequal, the Southern spot undergoing a much greater diminution both in extent and distance from the pole than the North, the latter having an area when at *its maximum* of five times that of the South; thus proving that while the South Pole has a hotter summer than the North, it has a colder winter,—a greater extent of snow and ice in winter, and a consequent greater variation of climate than the North, being subjected to greater extremes of heat and cold. The snowy extension of the Southern Pole reached in Feb. 7th and March 7th, 1837 (answering to Dec. 10th in Mars), the distance of 35° from the South Pole: in other words, to a latitude answering nearly to the British Islands on the earth. Thus there will be colder winters

in the southern regions of Mars than in the north, and hotter summers, and this notwithstanding the summer and spring in the northern parts are seventy-six days longer than in the south; but the greater heat and light received in the south compensates for its shorter summer, being 0.52 that of the earth at the south, and only 0.37 at the north. From these considerations Mædler arrived at the conclusion already put forward by the elder Herschel, "that in these white spots we behold a wintry effect, similar in every respect to a fall of snow upon the earth at that season."

But besides the general retreat of the snowy zones in summer, smaller changes and movements have been seen in these regions, some of which doubtless may be attributed to clouds of great extent moving, as ours do in similar cloudy regions on the earth; but others more probably arise from local causes, such as are experienced in our Arctic regions, such as the breaking up of ice packs and fields, and some of the changes observed even from a temporary fall of snow. Thus Professor Mitchell, of Cincinnati, relates in July, 1845, the sudden appearance of a strange dark spot in the very midst of the bright snow patch, and which was seen by several friends as well as himself. This spot having remained stationary for some time, disappeared, and was never seen again, being probably an extensive cloud. Again, on August the 29th of the same year, the entire outline and configuration of the snow zone was changed rapidly from the appearance and outline it had maintained for weeks: this was evidently the breaking up of a vast field of ice, a phenomenon familiar to all our Arctic explorers. Again, on the 30th of August, Professor

Mitchell saw a small *bright spot*, which was projected on the snowy zone, gradually detach itself from it, and moving onwards for a few days get out of the snowy regions altogether, after which it gradually became fainter, and at length disappeared. Some have imagined they saw this spot on the margin of the planet, and if so it was suggested that it might have been the Martial moon; but it is more probable that it was some vast bright snowy cloud moving away to a warmer region, where it was dissipated, as it would be here, presenting indeed a perfectly analogous case of meteorology with the earth.* The difficulty of observation of the surface

* Mr. Proctor gives a most interesting account of the visible rising of a cloud or mist from the surface of the ocean called "Dawes' ocean" in the map, and which was witnessed by two astronomers the same night, the first part of the phenomenon by Mr. Lockyer and the conclusion of it by Mr. Dawes, who has recorded it in his sketch. He thus describes it:—"On October 3rd, 1862, Mr. Lockyer was observing Mars late in the evening. He noticed a part of Dawes' ocean, where it borders on Herschel continent, was hidden from view. In place of the ordinary dark aspect of this region, a faint misty light, with ill-defined borders, was observable. As the evening progressed, he noticed that the outlines gradually became clearer; but when he gave up observation (at about half-past eleven), the white light still continued to veil the outline of a part of Dawes' ocean. Now Mr. Dawes observed Mars on the same night, at a quarter-past twelve. The drawing which he took at that hour shows that the process of clearing up noticed by Mr. Lockyer as being in progress in the earlier part of the night, had, by the time Mr. Dawes began work, entirely lifted off the veil which concealed the coast line. The remains of misty light seen by Lockyer are still to be detected in Mr. Dawes' drawing; but they have passed further south, and no longer hide the shores of Dawes' ocean."

Mr. Proctor makes the following interesting comment upon the above, as pointing to, and confirmatory of, the probable nature of the phenomenon then witnessed:—"From the observed position of the region in question, the *Martial time* of day there must have been somewhere about *noon* when Mr. Lockyer began his observations; and about one o'clock in the afternoon, according to our terrestrial mode of reckoning, when Mr. Dawes

† Proctor. "Other Worlds than Ours." (Page 96.)

of Mars arises quite as much, it must be remembered, from his own atmosphere as from ours; and the meteorology of the planet, which the spectroscope has revealed to be precisely similar to our own, leaves no doubt what to attribute such changes to, as, without leaving the earth, a similar picture is presented here. A very fine night for observation on the earth, however, may be a very bad one for seeing Mars, and *vice versa*.

The climate of Mars, so far as the proportions and divisions of the seasons are concerned as influencing it, ought to be quite as fine as the earth, and probably as warm. The spring, summer, and autumn, in his northern regions, occupy 522 days in all: *i.e.*, spring, 191½; summer, 181; autumn, 149½; while his winter lasts only 147 days (not quite five months) out of the 669 days, or nearly two terrestrial years. This large proportion of the finest seasons should give as the result a finer climate than we have, "*ceteris paribus*." Thus upon observation alone with the telescope astronomers formed the theory of the analogy of Mars' meteorology to that of the earth more than a century ago, and that the white spots were his polar snows.

Where snow is there must be water, and vapour, and condensation into clouds; the formation of air, and all the kindred phenomena we are acquainted with here,—thunder, lightning, rain, hail, and frost, and all the atmospheric and magnetic conditions that are inseparable from them. *Then* the dark "blue-green spots" were oceans,

observed the planet. It is no uncommon thing to see our terrestrial skies clear up soon after mid-day; and if the veil which conceals the Martial features is really cloudy, this is precisely what happened out yonder forty millions of miles away from us on the day in question." (Page 100.)

and the others (lighter colour) forests; while the continents and islands revealed themselves; and a pictured world was presented to our sight and mind upon observation and hypothesis alone. But *then* all was but conjecture after all, however probable; and the white markings might not have been ice, nor the atmosphere identical with our own, nor the meteorology of the planet in any respect the same. A new and unanswerable witness, however, has now appeared in modern times, and come to the assistance of the telescope, to confirm all that its larger companion has suggested or affirmed. The spectroscope has set the question at rest for ever, whether ice is ice in Mars, or whether the white which we see there is veritable terrestrial ice, or frozen water, or only something like it; and whether the moving clouds are simply terrestrial clouds in their composition,—*i.e.*, condensed water and vapour; and whether the air breathed, or to be breathed, there is *our air*,—familiar to us as the breath of our life, and the constituents of which and their proportions are precisely the same. Before the discovery of the spectroscope, this would have been impossible to discover; and even now that it is discovered, it seems almost miraculous that we should attain such knowledge. Yet the testimony of that instrument is infallible, and affirms beyond all doubt the identity of the two atmospheres: consequently the whole theory and hypothesis derived from observation is correct; and on looking at Mars we are actually looking at another and a smaller earth, and the whole Martial mechanism of his heavens is going on there just as it is here.

Thus modern science has effected a discovery, and

triumphed over a difficulty deemed insurmountable but a few years ago. The manner in which this was effected is not the least interesting part of the matter, as it is described by the most eminent of our spectroscopists, Mr. Huggins. He says, "Even the spectroscope was at fault at the first observation in distinguishing the difference between our own terrestrial atmosphere and that of the planet." After failing however in 1864, he was successful (even perhaps beyond reasonable expectation) in 1867, owing chiefly to one of those happy fortuitous circumstances that enable clever and intelligent men to avail themselves of an unusual opportunity afforded casually, and as though it were providentially, for the very purpose of the experiment, and consequent discovery. It is thus described by Mr. Proctor:—On the 14th February, 1867, he examined Mars with a spectroscope, attached to his powerful 8-inch refractor. The rainbow-coloured streak of the spectrum was crossed near the orange part by dark lines, agreeing in position with lines which appear in *our solar* spectrum when the sun is low, and the rays have to pass through a dense stratum of our atmosphere. To determine whether these lines were due to the atmosphere of Mars or that of the earth was now the difficult question. He turned the spectroscope accordingly to the moon, which, fortunately for his purpose, happened at this time to be nearer the horizon than Mars; so that if due to the earth's atmosphere, the lines ought to have been stronger from the moon than from Mars: but instead of this, the group of lines from Mars, seen in his light, were not visible at all in the lunar spectrum; hence the conclusion was irresistible,—that they belonged to Mars, and not to the

earth. Now the lines seen in Mars were identical with the lines seen in our own solar spectrum when the sun is low ; therefore the constituents of the terrestrial and Martial atmospheres must be in a great measure alike. But we know, from a careful analysis by Padre Secchi, that it is the aqueous vapour in our air which causes the appearance of the lines in question : hence there must be aqueous vapour in Mars ; and if so, all the phenomena attending its presence,—oceans, ice, snow, rain, etc. ; the condensation and dissipation of clouds, and the presence of winds wafting them from region to region of the planet, as here ; and supplying, by successive rain-falls, the great vegetable world with nourishment, to supply food for its fauna or animal creation. The existence of rivers, also, must be implied. If the clouds do bring water over every part of the Martial surface, there must be rivers to bear those floods to the ocean, which we actually see. But the existence of oceans and continents and islands (as Mr. Proctor truly observes) prove the “existence of volcanic forces in operation, and consequently the upheaval of mountains, down which the torrents find their way and make a bed.” Hence hills and valleys, rivers and mountains, cover the surface ; all the scenery, in fact, which renders our earth so grand and beautiful a habitation ; and likewise those geological changes and action with which we are familiar here, and which may be as reasonably looked for in this distant world.

In consideration of all these facts, the strange interest which the scenery and inspection of Mars excites in the human mind is unlike anything relating to terrestrial matters. As the unknown regions of the earth have

been gradually brought to light by adventurous travelers, such as Livingstone or Baker, much interest, it is true, is felt ; but sufficient general knowledge of terrestrial scenery and populations has been acquired to prevent any surprise at the wonders revealed belonging to our world : indeed there are but small portions of our globe that have not been visited and explored, and we know pretty well what to expect *here*. Not so however in a distant world, floating in the depths of space ; and of which we know nothing, but that it is a world like ourselves in so many particulars as to induce us to believe that it is probably, like our own globe, inhabited by beings not unlike ourselves. An impenetrable mystery, however, hangs over this part of the subject, and indeed over the entire globe and its circumstances, beyond those which are the subject of our actual observation, and which all our gazing or research cannot remove or penetrate.

As our eye, fixed at the telescope, follows the sinuous windings of its bays and promontories, or takes in the shape of its islands or the hue of its oceans, or watches the meteorological changes of its Arctic regions, an irresistible desire possesses the mind to know more ; and speculation, baffled, riots in dreams and imaginations of what is going on in that floating palace, that planet-ship,—not placed there for nothing, assuredly ; not placed there even to be admired or speculated upon by us. But what of the crew,—the inhabitants ? what of the detailed scenery ? Were we brought near enough, should we see its navies afloat on its sea-green oceans ? should we behold the smoke and busy movement, and hear the hum of its cities and their traffic ? Let us imagine our-

selves for a moment a solitary traveller just arrived on its surface: how strange our feelings would be when we found ourselves actually landed there,—breathing its strange air, smelling its strange flowers, inhaling its sea breezes, or listening to the lash of its tidal waves upon its shores, and looking out with wondering expectation, every step we took, for some token of its inhabitants! If we arrived there at the fall of eve, we should see our own world, left far behind us, shining with a greater lustre than Venus, and a greater diameter than Jupiter to us here. We should see our moon, too, like a little diamond spark, attending on our forsaken planet, and Venus and Mercury like two other diamonds of different lustre, if indeed the latter would be visible at all.

But what of the amount of light there? Did we arrive at mid-day with our present powers of eyesight, should we find *ourselves* groping in a twilight of half-solar light, while to the inhabitants of the planet, in consequence of a different construction of the eye, it was a brilliant day? That we should find storm, and clouds, and hail, and rain, and snow, and ice, in some parts, there can be no doubt; for we should recognise the very same air that we are breathing here. But what would be the average climate: should we freeze, as in our own polar regions, or melt, as in our tropics? And what would be our physical powers of exertion there? when we began to run should we find ourselves unconsciously going at twenty miles an hour without fatigue or difficulty, and taking a fourteen-feet wall as easily as a hunter would a five-barred gate?

Then what colour would the leaves of the trees and

the grass in this strange land be? Some have thought they must be red, in consequence of the planet's ruddy hue. This however is not probable, as large tracts of green can be perceived on the surface, though the example of our own red and scarlet beeches here show that it is not impossible. But the mystery of mysteries will be the inhabitants: not only the animal races existing there, the birds and beasts and fish, which probably are different from ours,—as different, at least, as they are found on different parts of our own world, or possibly as different as some of the fossil races on the earth were from the present animals. But the intellectual inhabitants: what of them? what are they? Material doubtless they are, like ourselves; and if man's form be the standard type of a god-like image, and the prevailing shape in which intellectual and moral powers reside (and I think there is every reason, from what we know of Christ, to believe that it is), it is as likely as anything else that the intellectual planetary races are all formed on the human model, so far, at least, as general appearance; so that if transported to Mars, we might not after all find ourselves in a land of strange beings with whom we could hold no communication. But what of their history, natural and moral? Here we must stop even our imaginings and speculations; true it is that we do know something of the moral history of other intellectual beings, who have their habitations in the heavens, or heavenly places: *i.e.*, angels. We know something of their appearance, and a little even of their material nature; something too of their rapid power of flight,*

* Dan. ix. 21—23.

and adaptation of their bodies to circumstances.* We do know that they exist in vast numbers;† that they hold (many of them) high and important offices and positions in the universe of God,—termed thrones and dominions, principalities and powers,‡ in heavenly places. What if many of the planets were the abodes of these glorious beings? What if Mars be one? What if the earth itself was once the abode of some such races before man's introduction to this scene, and were transferred from this world to make room for us? Such an idea is by no means extravagant to those who do not deny the truth of the Bible. The geological history of the earth, and the origin and tenancy of our race here, is involved in a mystery which has never yet been solved; and pre-Adamite races of such beings on the earth would go far to explain many of the difficulties that surround the subject of our own terrestrial history, as well as that which relates to the existence of intellectual beings resembling man in the bright worlds that shine above us, many of which are probably inhabited by such glorious creatures.

The general configuration, as shown in the maps and photographs of the surface of Mars, is a subject of much interest to us, as affording a comparison of the relative proportions of land and water compared with the earth. Mr. Williams accounts for its present configuration, or proportion of land and water, by his theory of planetary atmospheres, which he says derive their existence from

* Compare Gen. xviii. 2, 8, xix. 3, with Judges xiii. 6, 16, 20; and Mat. xxviii. 2, 4, with Mark xvi. 5, and Luke xx. 12.

† Heb. xii. 22.

‡ Coloss. i. 16.

contributions from the general atmosphere of space, and are dependent for *quantity* and *density* (i.e., for air and water, air and water being only *atmosphere* more or less condensed) upon the density and gravity of the planetary bodies respectively. Acting upon this theory, Mr. Williams differs from the generally-received and popular notions as to the climatal condition of Mars, derived from telescopic and stereoscopic observation.

This theory requires a greater quantity and density of atmosphere to Mars than has usually been assigned to him, and a consequent difference of meteorology and climate from that of the earth. He conceives, indeed, that they will differ so much that none of the creatures on this earth could live on Mars. The consequences of Mr. Williams' theoretical atmosphere would give Mars neither snow nor rain, with a barometrical atmosphere only five-and-a-half inches at his sea level, and consequent series of meteorological conditions diametrically opposed to that gathered a posteriori from previous observations and supposed fact. Mr. Williams gives Mars a climate resembling generally arctic Norway in May and June: foggy, but no clouds, constant hoar frost and oceans frozen to the bottom. Attributing such a climate to Mars, so contrary to the testimony of observation and fact, I cannot but think Mr. Williams does much to weaken his theory respecting planetary atmospheres, and which he is anxious to show corresponds in its results with observational astronomy. The results of practical observation certainly lead to a very different conclusion. Mr. Williams' theory, therefore, *in this respect*, should be received with great caution. Nevertheless, so far as the proportional divisions of land and water are concerned,

the circumstances of Mars from observation are curiously in agreement with it. According to Mr. Williams, the atmosphere of Mars, calculated according to his mass and density, should bear a proportion to that of the earth of *one fifth*. The quantity of water, therefore, upon his surface, should be to that of the earth in the same ratio,—one fifth; perhaps a little greater on account of excessive condensation. And if the relative average depths of the oceans of the two planets be about equal, the proportion of land to water on the surface of Mars should be four times greater than the proportion of land to water on the surface of the earth. The proportion of land to water on the latter being, according to Sir Charles Lyell, nearly *one in four*; or *one* of land to *three* of water. There should be then, according to Mr. Williams, on Mars, five of land to three of water. Now how does actual observation on this point agree with the result deduced by Mr. Williams from his atmospheric theory? Quite independently of any previous observation, he says:—

“Attached to the paper by Professor Phillips, to which I have referred, and from which I have so freely quoted, and to which I am so much indebted, is a carefully drawn chart of the land and sea of Mars, an equatorial projection extending to 60° of north and south latitude. I have divided this into 120 squares, and each of these squares into quarters, and have thus determined the relative area of land and water as there indicated. According to my theoretical requirements of five land to three water, there should be in 120 parts, seventy-five land to forty-five sea. I find on Professor Phillips’ chart seventy-nine land to forty-one sea. This is quite as near to the theoretical induction as can be expected or required.”

Mr. Williams likewise finds, in the beautiful little

chart by Mr. Proctor, an agreement with his theory of glacier erosion in the polar regions, another result of his *atmospheric* and *climatic* theory, in which he assumes the building up of gigantic conical ice-mountains, or bergs, the slopes of which, being melted in the Martial arctic summer, would be riven by gigantic ice-floods, and water-floods, avalanches, glaciers, etc., and the sides being undermined would bring about periodical catastrophes, by the more or less complete toppling over of the mountain cone in the form of a gigantic avalanche. “The rocks at the base of this great ice peak,” says Mr. Williams, “must exhibit on a grand scale all the effects of glacier erosion, polished, grooved, and dished, so as to form great circular valleys surrounding each of the poles of the planet, and beyond these, circumpolar furrowed-ridges of moraine.”

Thus, much of what Professor Phillips describes seems to agree in the main with Mr. Williams’ theory. And certainly, the beautiful sketch of the circumpolar regions of Mars, by Mr. Nasmyth, who specially notices what he terms “ice cliffs,” at the edge or boundary of the snowy line of the arctic circle, and where in the drawing there appears to be a dark shade or valley, seems to confirm the glacial character of this region; while the strange sight, witnessed on one occasion by Professor Mitchell, in this very neighbourhood, of the movement of a bright mass, first *upon*, and then moving across the snow boundary from the edge of the circle, seems to give additional probability to this supposition. Nevertheless, little else could be expected in that region, where vast masses, or even mountains of ice would probably be detached, and falling into the ocean would

float away as vast icebergs do in our own polar regions ; but this is not sufficient, even supposing it was the case, to prove that other parts of the planet did not enjoy as equable a temperature as our own globe possesses, in those parts where no such agencies are at work. But looking at the general configuration of land and water on Mars we are struck with the different laying out or apportioning of it from that of our own globe. The seas there are comparatively small, many of them land-locked, and more resembling inland lakes than oceans ; indeed, there are many of them that, strictly speaking, are but lakes. And although there are islands their number is very limited. Land transport to any part of Mars would appear to be much easier than on the earth. Of its mountain scenery, its forests, and its prairies, we can know nothing ; but we may well believe, from what we *can* see, that they exist as extensively in analogous proportion to the rest of the planet. Putting all these facts together then, shall we say they are prepared for *nothing* ! that no life exists there, especially no intellectual life, no material existence ? As well might we expect to find a palace, magnificently built and adorned, with its various apartments sumptuously furnished from the foundation to the top, with every comfort and convenience and appurtenance for being inhabited, and be told it was never intended for a habitation. It must indeed be a strange perversion of mind that can persist (after a close scrutiny of this beautiful planet, such as we have had) in refusing to see in it one of the many worlds formed by God as an abode for His creatures ; or resist the powerful conviction and conclusion that it is the seat of life in all its varied

forms of beauty and glory and excellence, as is perceptible in our own dwelling-place.

JUPITER.

PASSING onwards through the depths of space across a gulf of 500 millions of miles, encountering as we do so the wonderful zone of above 120 minor planets or asteroids half way on our journey, of which we shall speak hereafter, we now approach the grandest globe in the solar system, *Jupiter*,—the sovereign of our planetary family of worlds, and only to be approached in magnitude by his fellow-giant Saturn, which, with his wondrous ring, lies out far beyond him, separated by another vast gulf of 500 millions of miles, being as far from him again as Jupiter is from the sun. To either of these giant globes the earth is but a speck, being about the proportion of a garden pea to a large-sized melon: so insignificant do we become in the light of this stupendous world, or his ringed fellow,—the one attended by his four moons, the other by his ring and eight moons. While the earth is but 8,000 miles in diameter, Jupiter measures, according to the most recent measurements, 85,000; according to others, 87,000; while his volume or bulk is 1,200 that of the earth, and his mass or density 300 times ours. This latter quality, indeed, would be four times as great were the materials of which this great planet is composed of the same density as the earth; and were they so, the density of Jupiter would be 1,200 times the density of the earth. But as it is, his density, by the most accurate estimate, does not exceed water by more than one third; his preponderance over the earth in mass, therefore, is only to be attributed to his



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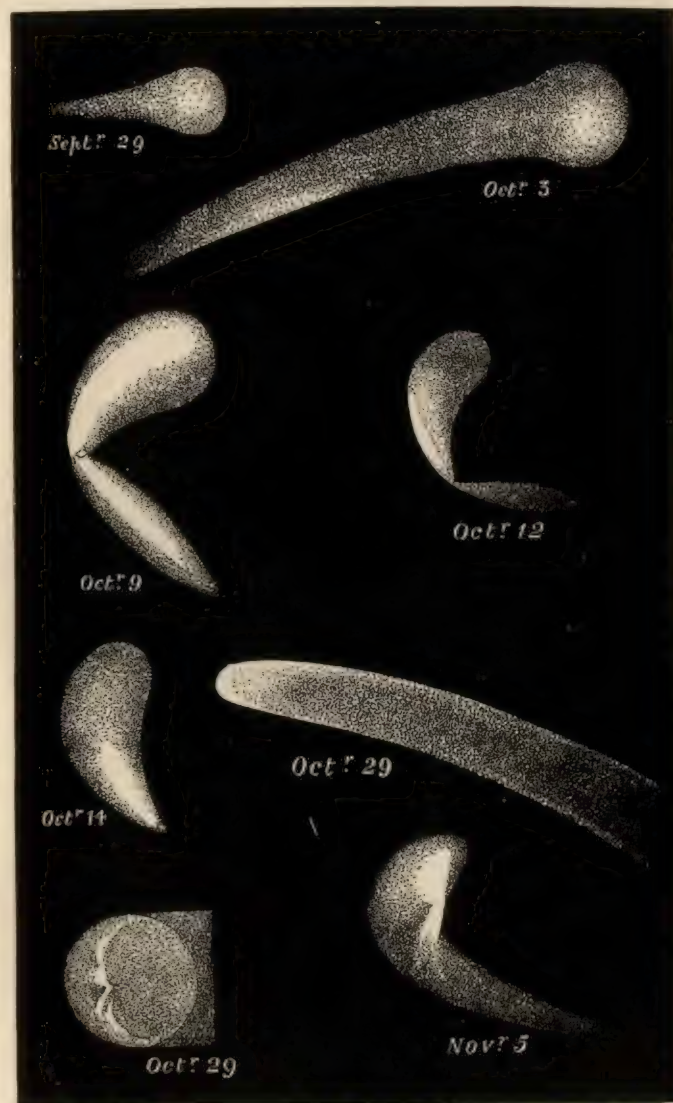
J U P I T E R



S A T U R N

superior magnitude, and is actually but 300 times that of the earth. But be this as it may, the appearance of Jupiter presents to the eye, as a world possibly inhabited or intended to be inhabited, the grandest sight in the solar system; and the more so as, surrounded by four satellites or moons revolving round him, he affords a representation in miniature of our own solar system,—*his* moons revolving round *him* as his companions do round our sun. Were we to approach this stupendous globe as near as our moon is to us, he would appear to cover a space in the heavens fourteen hundred times the apparent diameter of our moon to us: such is indeed his actual appearance to his own nearest satellite. The effect to us would be past conception: the entire hemisphere would appear to us filled with his circumference; while the *lustre* and *brilliancy* of his *surface*, which although at such a vast distance from us shines with a lustre more than three times that of our moon, would shed upon us a light as bright as day; while his four moons would lend their additional borrowed lustre to the scene. Such a light is probably beheld from the nearest of the four moons to the inhabitants of it, if any there are.

But what, on the other hand, would be the appearance which our sun would present to the inhabitants of this enormous planet? and what the consequences of his position, or results? These we shall find to be most important. And here the case is reversed from that of those planets that lie within the orbit of the earth, or as in the case of the earth itself; and instead of the broad and glaring solar disc (as large nearly as Jupiter himself appears to his own nearest satellite), as the sun would appear to Mercury, or even the more moderate-sized



PHASES OF HALLEY'S COMET,

1835.

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disc from which light and heat reach *our* planet here, which enables us to live in moderate warmth and comfort, this distant sun seen from Jupiter would seem but a star,—would shine upon him with a diminished lustre and light, but *one twenty-fifth part* of that which we receive here, and exhibit a disc proportionally small, —both the magnitude and intensity of the sun's heat and light decreasing, in a very great proportion, as its distance is increased. Thus the distance of Jupiter from the sun being five times that of the earth, the apparent diameter of the sun's disc, as seen from his surface, will be *one fifth* of its diameter as seen from the earth; and as the light and heat which he would supply to that huge planet would be in the proportion of the surface of the solar disc, and as the areas of surfaces are as the squares of their diameters, it follows that the light and heat distribution to Jupiter by the sun would be (unless there be some peculiar and special arrangement for preventing it or modifying it) twenty-five times less than that at the earth.

This is the first great *apparent* obstacle to the idea of Jupiter being an inhabited world, that meets us on the *threshold* of inquiry; for the consideration of his superior magnitude to every other planet in our system, and the circumstance of his magnificent escort of moons (apparently given as compensation for the feebleness of solar light), otherwise naturally impresses us at first sight with the all but certainty of his superior importance as a world, and consequent inhabitation by a population suited to the grandeur of such scenes as would be presented to them on all sides,—either from the stupendous globe itself, with its giant mountains, oceans, rivers, valleys, and forests,

all proportioned to his size, or to the heavens above him, shining continually with the four-fold lustre of his four diamond-like satellites. And yet this first delightful impression, whether true or false, is dimmed and weakened by the first great truth that meets us. If the sun shines upon *this planet* but as a feeble taper to light and warm him, how can he be an inhabited world, —inhabited at least by beings in any respect resembling man? True, this last is not necessary; and as there are races on earth accommodated by the Divine arrangements to every different climate, and who could not exchange climates without death to each, so it might be here. And the inhabitants of this mighty globe may not require the same amount of heat and light which man does: their eyes (as Dr. Lardner happily suggests) may have larger pupils, or a greater sensibility of retina, either of which or both would compensate for the diminished solar disc, which difference of organization would enable them to see quite as well as we can with the bright terrestrial sun;* while the diminished heat and calorific might be compensated by modified atmospheric conditions, as we find with the *same density of solar rays* on *earth*,—where we may experience all climates when we ascend on tropical mountains to various altitudes, from the level of the sea to the line of perpetual snow.

Professor Tyndall, indeed, has endeavoured to show, on scientific principles, the manner in which it would be possible to convey ample heating power to Jupiter and the other exterior planets through the medium of their

* Moles and owls are instances of this.

atmospheres. Notwithstanding their great distance from the sun, he says (referring to Whewell's estimate of the sun's heating power on Jupiter), "the influence of an atmospheric envelope was overlooked, and this omission vitiates the entire argument." It is perfectly possible to find an atmosphere which would act the part of a barb to the solar rays, permitting their entrance to the planet, but preventing their withdrawal: for example, a layer of air two inches in thickness, and saturated with the vapour of sulphuric ether, would offer very little resistance to the passage of solar rays, but would cut off fully five per cent. of the planetary radiation. It would require no inordinate thickening of this layer of vapour to double the absorption; and it is perfectly evident, with a protective envelope of this kind, permitting the heat to enter but preventing its escape, a comfortable temperature might be obtained on the surface of our most distant planet. This is high authority for what, indeed, we might easily conclude even without it: viz., the highly probable and wonderful adaptation of life and its effects to the circumstances in which it is placed; as also the adaptation of those circumstances to the probably infinite variety of life, dispersed by the Almighty and All-wise through his never-ending dominion of worlds.

The difficulty therefore experienced in peopling Jupiter, in consequence of want of light and heat on his surface arising from his enormous distance from the sun, may be fairly disposed of, both in his instance and that of the planets that lie out far beyond him, but which yet are obedient vassals of our sun, and drink in their comparatively small measure of his light and heat at a dis-

tance of three and four times that of this noble world. The arrangements for this two-fold purpose then, we may rest assured, are as complete and certain as that which first placed them *where* they are and made them *what* they are. But setting aside this consideration, there are other circumstances connected with this gigantic planet, derived from his appearance, and which seem to indicate that special provision has been made for light and heat, both by day and night, far exceeding that which we might imagine from the single fact of his great distance from the sun.

It is plain that the brilliancy of his surface greatly exceeds what might be expected from what we have said; and though not so dazzling as Venus or Mercury, yet the disc of Jupiter, seen in the telescope, is certainly the most splendid object that the human eye can rest upon in the heavens: among the planets, indeed, there is not one to compare to him. Venus, though beautiful to the naked eye, in the telescope is but a dazzling glare, almost unbearable. Mars, deeply interesting for other reasons, yet shines with a dull red light inferior to any; while even Saturn, with his beauteous and wonderful ring, is silver or platinum compared to the glorious *steady* golden or silver hue of this stupendous stately world. No one, I believe, ever saw it for the first time in a good telescope, with its four diamond-like attendants, without an exclamation of delight and admiration: and one can faintly realize the rapture of him who the first saw it through a telescope, and brought back the astounding intelligence of what he afterwards called the *Medicean stars*, or moons, in honour of his patrons; and which Galileo, with that happy, quick, and almost instinctive

appreciation of great truths which belongs alone to genius, at once and rightly understood, as he watched their movements, to be satellites to the great world they enlighten.

But, it may be added, to what cause is such brilliancy to be attributed? or how, at such a distance from the sun, is it possible Jupiter could exhibit such a gloriously enlightened disc,—the light from which, reflected as it is, shines with a lustre that has been calculated to be far beyond that which Mars, the earth, or the moon *could* possibly reflect, were they placed where Jupiter now is, and enlarged even to his magnitude? It has indeed been said, by Mr. Bond of America, that Jupiter sends us more light than he receives from the sun: but whether this be the fact or not, it has been ascertained that Mars reflects but one *fourth* of the light he receives (*i.e.*, three fourths of solar light are lost in Mars and only one fourth is reflected): so the moon only reflects less than *one fifth* of what she receives; Saturn only *one half*; while Jupiter actually reflects more than *three fifths*. If these researches of Dr. Zollner, the great photometrician, are to be depended on, there must be something peculiarly reflective on either the surface or the atmosphere of the great planet to produce this effect.*

To account for it, it has been suggested by Mr. Proctor, Mr. Williams, and others, as the latest and most probable theory, that Jupiter must shine partly with his own light and partly from reflection: that, in fact, he is to be looked upon now as a miniature sun, or rather an unfinished and uncompleted planet in a state of fluidity and intense

* Proctor.

heat, shining partly from reflection and partly from his own light; by which also additional brilliancy as well as heat is given to his satellites, which are certainly wonderfully brilliant objects considering their vast distance from us and their minute size. Of the validity of the theory I shall speak in another place; but at present I would merely call attention to the brilliancy of Jupiter and his satellites, as quite as probably indicating that by some means, which we are unable fully to explain, an immense quantity of light, and it may be presumed heat likewise, are communicated to him from our sun, and are *reflected* from his surface, *not originated beneath it*,—quite sufficient to assure us at a glance that *if he be not a minor sun*, which I do not think he is, he is at all events in possession (as a planet) of abundance of those two essentials for a habitable world sufficient to constitute him one of those finished globes which are inhabited by beings who need and enjoy both. And we may, I apprehend, safely impute this extraordinary brightness to the peculiar *reflective powers* of his atmosphere. Let us therefore see what his *atmosphere* exhibits, and if anything to warrant such a conclusion may be conjectured, so far as may be estimated by the remarkable appearance it presents in the telescope.

And first it must be assumed that the apparent splendour of a planet,—shining, as is supposed, only by reflected light,—will depend conjointly on the apparent area of its disc and the intensity of illumination at its surface. But the intensity of illumination at the surface will depend likewise conjointly on the *intensity of the sun's light at the planet*, and the *reflecting power of that surface*.

Now, to account for the superior apparent brightness of Jupiter, notwithstanding his enormous distance from the sun, and consequent diminution of the sun's light to be expected at his surface, which, comparing it with the planet Mars, would be thirteen times less, what have we to say? Without calling to our aid the supposed self-originating light arising from planetary combustion below the surface, it is plain there are only *two conditions* that *could* produce it, and thus overcome the diminished splendour produced by distance. One is, the greater *apparent area* of Jupiter's disc, which compared with Mars is *fourfold* that of the smaller planet, its *apparent diameter* being twice as great. Thus far, on this ground alone, the disproportion of splendour between the two planets would be lessened, but not sufficiently, as it would still leave the balance of brightness on Mars' side; which, on the supposition of the reflecting powers of the surface of both the planets being equal, would leave the apparent splendour of Mars, by reason of his greater proximity to the sun, still three times that of Jupiter. The *reflective powers* of Jupiter must therefore be greater in sufficient proportion to explain his vastly superior illumination, notwithstanding his greater distance,—and to this cause chiefly, aided by its greater area, doubtless, are we to attribute the *general* superior splendour of this great planet, though removed by such a vast distance from the source of its illumination.

It has been calculated that a surface of an illuminating power on Jupiter equal to white paper would be sufficient for that purpose. That clouds and vapour are capable of a reflective power not only equal to this, but far greater, I think there is no doubt, although I am not

aware of an actual measurement or analysis of the comparative light-reflecting powers of each of these substances. I think any person, however, who has observed the intense dazzling whiteness of the cirro-cumuli of our own planet when illuminated by a strong sun, will be inclined to act the part of judge and jury in this case without formal trial, and give a verdict in favour of the *cloud* to the paper. But what are our terrestrial clouds, or the largest collection of them that could be brought together, to that which the wondrous cloud-surface of Jupiter collects in one enormous mass of resplendent white or golden glory! What would a cloud-surface of 8,000 miles be to one of 87,000; for there is reason to believe that we see little else than clouds on the surface of Jupiter? The total effect of such a gathering, even with a diminished sunlight thirteen times less than that upon the earth, would be (as I take it) quite sufficient to produce an illumination far beyond any other planet in the heavens (except the two inferior planets, which, plunged in the depths and blaze of solar rays, are little suns themselves), but amply sufficient to exhibit to the eyes of terrestrials the actual splendour which the surface of Jupiter does present. So far, therefore, as accounting for *his apparent brightness at least*, it would seem to me unnecessary on this account to call in the aid of self-originating light.

But there are other circumstances which are adduced by modern astronomers tending to overthrow the formerly-received doctrine of the completed planetary condition of Jupiter, and to establish that of his being an unfinished world in a *molten* state (as stated by Mr. Proctor), or red-hot or white-hot (as affirmed by Mr.

Williams.)* Let us direct our telescope to his surface. Any one who has ever seen Jupiter in a telescope, has remarked not only his general splendour, but extending across his disc what have been called belts: *i.e.*, certain dusky lines of varying breadths, and *generally occupying a permanent position*, but occasionally deviating from it, with a power of forty, which shows the disc as large as the full moon, these belts are sufficiently conspicuous; but to observe their details fully, a power of near 200 will be necessary. Thus seen, the oval shape of the planet will be then perceptible, being an oblate spheroid flattened at the poles, and the belts clearly defined. The dusky lines had formerly been considered by early observers to be clouds floating on the surface, as dark rain-clouds do in our clear and bright atmosphere; and to indicate the presence of an extensive watery atmosphere. This opinion, however, was subsequently abandoned; and Sir William Herschel suggested the more probable conclusion, that the dark lines separating the broader bright patches, or general brightness of the planet, were but glimpses of the solid body of the planet beneath, or a dark stratum of clouds, and produced by rapid rotation of the planet on its axis; and indicating a condition something resembling that of our trade winds, or a lower stratum of dark clouds, as the dark lines generally lay from east to west across the planet's disc, leaving a broad bright belt of the same hue as the rest of the planet across the equatorial region. This more probably *suggests* land. Closer observation, however, both by Sir William Herschel and others since, have shown that

* "Fuel of the Sun." (P. 189.)

though this is the normal condition of the planet, the belts (*i.e.*, the dusky lines) are subject to great variations, —sometimes intruding obliquely on the broader and brighter belts, sometimes varying their latitudes so as to cause a corresponding change in the breadth of the bright belts, and especially of the equatorial belt. Sometimes a dark belt would disappear altogether in a moment; while on a few rare occasions the entire disc of the planet seem to be broken up into small portions, and the belt system all but destroyed, as though some great and violent and unusual agitation had occurred; but afterwards returned again to its former or normal state. All this evidently implies that what we see of the disc of Jupiter must be nearly, if not *altogether*, atmospheric; and that if we do see any of his solid body, it is to be found in the dusky belts, which reveal his surface through the general atmospheric covering that surrounds him, and which is disturbed by greater or less agitation, owing to causes similar to those which agitate our own atmosphere. It is true that even these dark narrow belts or lines might themselves be but an under stratum of clouds, showing black by contrast with the superior brightness of the outer cloud surface. But this point has never been fully cleared up. Whichever be the truth, however, it is certain that a considerable and probably a dense atmosphere surrounds this great planet; and that it is highly probable *we* see nothing but this cloudy envelope. It does not follow, however, that the inhabitants (if any) may not see through a great portion of the atmosphere which hides the planetary surface from *us*. The effect of looking at a distant planet surrounded by its atmosphere, as we do, is very different from looking out

through it by those enveloped by it, as we are on the earth. The *effects* of sunshine visible upon an atmosphere from *without* is often the very reverse of what is seen *within*,* as we know by our own atmosphere; and many clouds that are *black* or coloured to us here below, would be reflected in *white* were we above them on the summit of a lofty mountain or in a balloon. Therefore we can form but little notion (in any way that can be called *positive* or *precise*) as to which is *cloud* or *sky* † or *solid* body on the surface of Jupiter. It may be that through a thin and hazy mist, or air of golden or silver *hue* (*i.e.*, of such colours as the broad belts of Jupiter assume), the eyes of the inhabitants may see every star in their heavens, including their own satellites and the earth, while we cannot penetrate it from here. At such a *distance* as we are situated it would be impossible to say they cannot; nor to assume as a certainty more than the fact, which is incontestible, that Jupiter has an *extensive atmosphere*,—one that is liable to great changes and agitation occasionally, like our own; but that the *generally permanent* or *normal* condition is quite perceptible, and bears a striking analogy to the terrestrial atmosphere in many particulars. Among these the atmospheric currents forming in lines, produced doubt-

* We have an illustration of this in the difference between *looking out* of a window covered by a white muslin blind, and *looking into* the same window. Every object can be seen plainly from *within*, while from *without* nothing can be seen but the white reflection of the blind.

† It should be remembered that the *air* of planets is probably coloured as well as their clouds, and this circumstance may make it difficult for us to distinguish the planetary surface as well as the cloudy or foggy screen. The colour of our air when cloudless is blue to *us*. Is it *blue* to spectators from other planets? Of what colour is the air of *Jupiter*?

less partially by the rapid rotation of the planet on its axis, suggests, as the two Herschel's originally thought, an analogy with the trade winds of our globe. Let us see how this is borne out by fact. It is a well-ascertained fact that the trade-wind currents of our globe, as they are called from their permanence and utility to sailing vessels, are to be found on the earth in the very same position as the dusky lines are found in Jupiter (viz., on either side of the equator), or from 28° to 30° north or south of it; deviating from north-east or south-east according to the position of the sun; and as his declination is either north or south, the solar rays acting as a moving power in altering their direction: the equatorial district that lies between the northern and southern currents being what is called the belt, or district of *calms*, well known to those who cross the line.

The cause of the phenomena of the trade winds, and also the calm belt, is well known to be owing to the *rotation of the earth on its axis*, combined with *the action of the vertical rays of the sun on the equatorial regions*. Although the earth's atmosphere is carried round with it in its diurnal rotation on its axis, as though it were a part of it, yet anything that disturbs its own perfect equilibrium will cause it to *lag* in its movement, as it were, behind the earth's motion, which outstrips it; and the consequences will be the phenomena of the trade-winds,—the more rapid motion of the earth causing an air-draught, such as we experience when on the engine of a railway at full speed, or a fast-going steamer. But for the equilibrium being disturbed, there would be a perpetual calm all over the earth; but a stagnant atmosphere would not subserve the purposes of the Creator in

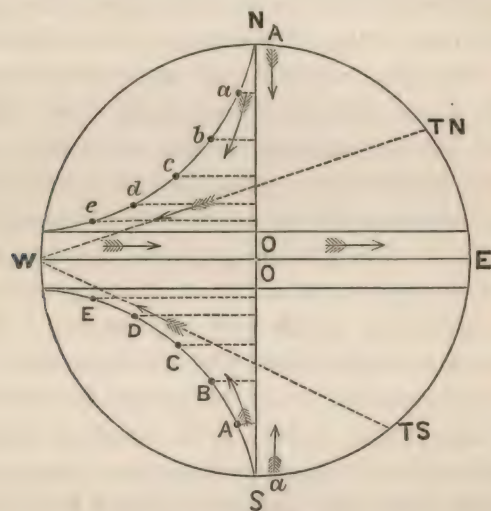
supplying His creatures with fresh and refreshing currents of air continually, besides the other and more important purpose shown on the grander scale evinced by the trade winds.

Now, there are several causes of disturbance continually occurring to the earth's atmosphere, that are ever moving it, from the gentlest zephyr to the wildest hurricane, besides the continued and steady wind-draught of the trade winds, that blow constantly from either the north-east of the equator or the south-east. These causes are (to take them generally and popularly), first, the *sun's influence*: that by causing different *temperatures* in different localities, as his rays are brought to bear upon the atmosphere *vertically* or *obliquely*, destroy the perfect equilibrium of the air,* and causing it thereby to lag; and, secondly, when this has been done by the *constant* and *incessant* but oft *changeable pace* of different parts of the earth's surface in its rotation, which disregards all causes of delay on the part of its companion the wind to keep pace with it; to which may be added lastly, as a third cause, opposing solid obstacles on the earth's surface, such as mountains and forests and valleys, all of which act as so many drags upon the fruitless effort of the wind to keep up with its planet earth in its revolution.†

* Cold currents rushing in to fill the places heated by the vertical rays; while alternate condensation and evaporation of the *watery* portion of the atmosphere generates constant changes and circulations from the lower regions to those above, and *vice versa*, while electricity comes in to aid in a more violent manner the total prevention of a constant equilibrium.

† The lagging of the wind *from this cause* is thus described by Sir John Herschel on the basis of Hadley's "Theory of the Trade Winds," 1735, who was the first to give the true explanation of what he terms the magni-

Now could we get a bird's-eye view of our planet rolling round on its axis, leaving its struggling companion the air, often cloud or thunder-laden, behind it,—ever pressing forward, while the latter is busily engaged in getting up a storm somewhere,—now a vertical,



TRADE WINDS.

Imagine W. N. E. S. the globe of the earth, revolving on its axis N. S. from west to east, in the direction W. E., as indicated by the arrows on the equator W. E. Let S. O., N. O., indicate the currents of air from the poles to the equatorial regions, on the supposition that the earth was at rest; *A B C D E*, and *a b c d e*, the actual direction of the polar currents in their passage to the equator, in consequence of the earth's rotation on its axis, the earth gaining on the wind in each point of its transit, *A B C D E*, and *a b c d e*, on account of the greater velocity of the equatorial regions, and thus causing north-easterly trades (N. T.) and south-easterly (S. T.) in the neighbourhood of the equator.

ficient phenomena of the trade winds,—first partially suggested by Galileo, who however did not arrive at the perfect solution of it:—

“The equatorial portion of the earth's surface has the greatest velocity of rotation, and all other parts less, in the proportion of the radii of the circles of latitude to which they correspond. But as the air, when relatively and apparently at rest on any part of the earth's surface, is only so because in reality it participates in the motion of rotation proper to that

now a horizontal whirlwind,—now stopped by yonder Alpine or Himalayan summit, and obliged to go round through the valley,—now retarded by the rough tops and trunks and branches of yonder forest,—now endeavouring to make up for lost time by sweeping over that African desert,—but all in vain: nay, even when out in the great Atlantic or Pacific, unable to overtake and keep pace with our great world, of which it is the aerial satellite; but though keeping at a tolerably fair pace, yet lagging enough behind our labouring globe, as it spins on its course, to keep up a steady, fresh, and constant breeze: if we could see all this enacted by the great material agencies of the Almighty here on *our surface* (as a speculative and curious angel might, and possibly does look into these things, from a post high in space), we should see probably many of the very same strange sights that are now exhibited by a grander world than ours, and of course on a grander scale (*viz.*, the working of *earth* and *sky* and *clouds*, just as we do here), and this without having recourse to *violent* volcanic action below, or a state of molten heat or

part, it follows that when a mass of air near the poles is transferred to the region near the equator by any impulse urging it directly towards that circle (that impulse being the high temperature constantly maintained between the tropics, which causes the colder winds to flow towards that region), then it follows that in every point of its progress towards its new situation it must be found deficient in rotary velocity, and therefore unable to keep up its speed with the new surface with which it is brought in contact. Hence the currents of air which set in for the equator from the north and south must (as they glide along its surface) at the same time lag, or hang back, and *drag upon it* in the direction opposite to the earth's rotation, that is from east to west. Thus these currents, which but for the rotation would be simply northerly or southerly winds, acquire from this cause a relative direction towards the west, and assume the character of permanent north-easterly and south-easterly winds.”

fluidity; but simply to the causes which we find in full operation here.

In Jupiter therefore, as on this earth, we may expect to find, *and do find* (on the theory of its being in the same condition as ourselves), appearances such as we should see in our own: viz., a broad belt of *calms* across his equator; on either side, the lines of the trade winds, expressed in the dusky lines there to be seen; *more permanent* than ours, because the rotation of the planet is not only more rapid, but the inclination of the axis is not like that of the earth, but permanently at or nearly at right angles to its orbit; and therefore, save when the solar or magnetic influence is at work in altering the *temperature of the Fovial rays*, and causing thereby such breakages and alterations in its cloud-world as are seen occasionally,—presenting permanently and normally those beautiful regular belts of alternate light and darkness which derive their origin, first, from the atmosphere, generated by the oceans below and the air that surrounds him; *and next*, by the *rapid passage of every point of his gigantic surface through it*.

Here then, from this source at least, I think there is no occasion to beg the question of the condition of Jupiter being that of *a melted or fluid mass*,—a semi-sun,—an uncompleted world,—giving out from its molten surface light and heat to its satellites, and unfit to be a habitable globe. The action on its surface does not appear to require this, or anything more than is going on here in our own heavens, *only on a diminished scale*.*

* It may be here objected that in tracing the analogy of the trade winds on our earth with those of Jupiter, or *vice versa*, credit has been given in that planet for an equal amount of solar heat at the equator, as is known to exist

But a good deal of importance has been attached to the circumstance of the colour of the bright belts of Jupiter, as recently seen in some telescopes, especially reflectors, such as Mr. Browning's admirable glass reflector. No doubt these reflectors do enable us to perceive colours which are not visible in refractors; and there is no reason to doubt that they reveal the *truth*: but of what consequence is this in determining the tremendous conclusion that because, for instance, the middle equatorial belt of Jupiter is changeable in colour, and occasionally exhibits a deep yellow or copper tint, that therefore it is significant of fire beneath, or a molten state. Yet this does not appear to me equally conclusive. If there be a thing in the world that we see before our eyes constantly *here*, it is the varying colours of the clouds and of *our* atmosphere. It is no exaggeration to say that at our different sunsets and sunrises especially, every colour of the rainbow may be *successively* seen by a constant observer; not, of course, at the same moment, but a different colour *each time*; no two sunsets being alike. Who has not seen rose colour and majenta skies,—green, violet, yellow, and

here. But that such cannot be the case is already shown from the vast distance of the planet from the sun. And yet that the trade winds of our globe are in a great measure owing to the changes of our temperature caused by the sun, thus creating different currents of air in different places,—the Polar currents being directed to the equator from the greater heat of those parts. It should be remembered, however, that the part the sun acts in the trade winds is but a subordinate part,—the only effect produced by solar influence being to give them a northerly or southerly direction. But with Jupiter there is nothing of this kind apparent, nor is the solar influence needful in producing this; but taking into consideration the inclination of his axis to the equator, and assuming the existence of an atmosphere attached to the planet, like ours, the winds on his surface would blow directly *east* and *west*, and as they appear to do.

copper colour, and purple,—sometimes *one colour* or hue prevailing to such an extent as to leave no other to be seen in the heavens? * Have we not seen auroras, too, that appear sometimes to encircle our entire globe in their ruby crimson folds, or white and green?

And if it be the case that our own globe here can in a moment put on its coloured cloud-robcs of every hue, and change them with equal rapidity—one colour for another—without any extraordinary disturbance, why may not Jupiter, the king of planets, array himself in his kingly garments,—now with a golden or ruddy belt, and again exchanging it for a *silver* one, or *copper* or *steel*, as I have frequently seen him do myself? and this without the necessity for believing that there is a burning furnace of glowing metal and boiling oceans beneath its lovely and generally calm and brilliant surface. So far as changes of colour are concerned, however curious and rapid, I think no certain evidence whatever can be derived from it as to the fluid state of Jupiter.

But looking thus at the appearance of Jupiter's surface, have we any feature that will enable us to judge of the extent or depth of his atmosphere? Mr. Proctor says the question, so far as he knows, has never been considered; but is well worth careful study. He suggests, likewise, that if the bright belts are really cloud-belts, and the dark belts the surface of the planet, then, on the edge of the planet's disc, we ought to see some

* But what a small portion of the heavens is visible to any one person here,—embracing, as our most extensive view does, only the portion of the heaven bounded by our own horizon at the utmost; and seldom even that, except at sea! How much more *extensive*, and probably striking, would the cloud-colouring of our world be, if we could get in one view the entire diameter or *disc of the earth*, as we do of other planets!

irregularity of level; the cloud-belts,—*i.e.*, the bright surface projecting slightly beyond the *black* or real outline of the planet (*i.e.*, if the atmosphere has that enormous extent which some astronomers have supposed). Whether such an appearance has been looked for, he does not know; “but,” he adds, “it certainly has never been detected.” * Dr. Lardner speaks more confidently as to the probably limited extent of Jupiter's atmosphere. He says:—

“That the atmosphere has not any very extraordinary height above the surface of the planet is proved by the sharply-defined edge of the disc. If its height bore any considerable proportion to the diameter of the planet, the light towards the edges of the disc would become gradually fainter, and the edges would be nebulous and ill-defined. The reverse is the case.”

Mr. Williams and Professor Leitch, on the other hand, attribute an immense depth of atmosphere to Jupiter. The former says † that its depth is so great that his body must be ever hidden from human sight, and his visible disc is but the reflecting surface of his enveloping cloud sphere. Professor Leitch, of Queen's College, Canada, confirms Mr. Williams' opinion, and says:—

“The disc of Jupiter presents very singular phenomena. There are indications of constant commotion; and the markings of the belts often present very perplexing forms, of which no account can be given. *We only know* that the visible disc is not a fixed and solid crust: it is like the visible envelope of the sun, which conceals the solid nucleus in the interior: there is no evidence that we have ever as yet seen the kernel within the outer shell of Jupiter. The usual explanation of the dark

* PROCTOR. “Other Worlds than Ours.” (Page 130.)

† WILLIAMS. “Fuel of the Sun.”

belts of Jupiter is that they are the more transparent parts of Jupiter's atmosphere; while the brighter parts are the region of clouds, which reflect the light more abundantly. In this hypothesis we see the body of the planet down through the transparent regions of the dark belts; but it is more probable that in the dark belts we see only part of its interior shell, and that the real body lies far beneath. The dark belts would in this way correspond to the penumbra of the spots on the sun, which are really only an increased part of the stratum immediately under the luminous envelope."

The conclusion of both these astronomers, it appears, is the same as to the probable *great depth or extent* of the *atmosphere of Jupiter*; and is the more significant as they have arrived at that conclusion by different ways. Mr. Williams reasons solely, according to his own peculiar hypothesis already referred to,—that the atmospheres of planets will be in proportion to their volume and density; Professor Leitch, on the other hand, from observation alone. The coincidence would at all events seem remarkable, and for that reason of *importance*, both as to the correctness of Mr. Williams' theory *so far*, and the conclusions drawn from it as to the extent of the Jovial atmosphere. But *nevertheless*, I take it, it remains yet to be proved,—if proved it ever can be, *beyond doubt*. If, as Professor Leitch says, there be no evidence that we have as yet ever seen the kernel within the outer shell of Jupiter, neither (it may be as truly affirmed) is there any distinct or certain evidence that we *have not*. In truth, at the enormous distance at which the planet is situated, great uncertainty and doubt must rest on all that we *see* there; so great, indeed, that at this moment it would be impossible for *any man*, however great his talents or astronomical attainments, or keen his sight, or

excellent his telescope, or however plausible his theories may *seem*, to pronounce, to *demonstration* (as *can be done in the case of Mars*) the *cause* of the *actual phenomena of Jupiter's surface*. Mr. Williams, from his hypothetical point of view, is of opinion that Jupiter has reached his *permanent temperature*, which he describes as being a *red* heat, or rather a *white* heat; in other words, a sun, and consequently never could be a *planet* at any time. This conclusion he arrives at on the theory of a comparison of the relative masses and diameters of the *earth* and *Jupiter*, and the consequent atmospheric pressure upon the latter, which as the Jovial atmosphere, thus calculated, should be 6,232 times that of the earth, would leave an atmospheric pressure upon the surface of Jupiter equal to 49 atmospheres: *i.e.*, 740 lbs. per square inch, equal to a column of Mercury 134 feet high. This enormous pressure would give 2,259° fahr. as the temperature produced in the lower regions of Jupiter's atmosphere by its own condensation. This, he says, is the melting-point of cast iron; and, indeed, may be accepted as an under statement both of pressure and heat in the lower regions of the planet. Mr. Williams then sums up the conclusion of his theory of the condition of this great planet:—

"I have little doubt that Jupiter is *still red hot*, or rather *white hot*; that a vast depth of aqueous and other vapour surrounds it; and that these, together with the free oxygen and free nitrogen, form a very much greater atmosphere even than I have calculated. I think it extremely probable that the temperature of *dissociation of water* has been reached by the atmospheric compression of Jupiter; that he must have manifested some degree of *general solar phenomena*; and that if we could see him shaded from the solar rays, he would appear like a phosphorescent, or rather a fluorescent ball, by the illumination

of his vaporous envelope, due to the light it absorbs from the glowing world within."

Apologizing for the appearance of extravagance in this hypothesis, which, he says, is entirely due to the novelty of the idea and not to its inherent character, he adds:—

"The assumption of *solidity* and anything like terrestrial temperature, such as are usually attributed to Jupiter, is, in spite of its familiarity, really an extravagant hypothesis; *for there is no kind of matter of which we have any knowledge that could form a globe, having the dimensions and specific gravity of Jupiter, unless it were heated to a state of fusion.* The solid shell, enveloping liquid and gaseous matter lighter than itself (which has been suggested and is still generally adopted), crumbles and melts away at the touch of sound reasoning based upon the *established facts of experimental science.*"

It is remarkable that the conclusions of Mr. Proctor and Professor Leitch respecting the probable condition of Jupiter, should, though arrived at in a different way, and more cautiously expressed by the former, be *nearly* the same as Mr. Williams'. And yet, while giving all respect to the opinions of such able astronomers (especially to Mr. Proctor, who, with a true philosophic spirit, advancing step by step with his items of evidence, avoiding all dogmatic statements, rather places the facts before us than asserts their certainty), yet, with all due deference to such high authority, I feel compelled to demur to his conclusions, at least until something more decisive than anything that has yet been adduced has been afforded, to lead me to consent to the overthrow of the older and more popular *Herschellian doctrine*. The argument of most force, and perhaps the most difficult to be met, is that which is connected with the *mass and*

density of Jupiter; and after all this can only be *conjectured*, not *demonstrated*, and all else, derived either from theory or telescopic observation, must necessarily be more or less guesswork, and uncertain.

But the remarkable circumstance of the supposed specific gravity of Jupiter is an important item in the testimony to the novel and startling new theory that Jupiter is a *minor sun*, or an *uncompleted planet*. Let us therefore examine it.

Mr. Williams' theory is too new itself* to place that dependence upon it and its results that are required for the overthrow of a doctrine established by such men as the two *Herschels*, and all the most eminent astronomers of the last two centuries. Very often, indeed, it has been found that a theory just as probable and ingenious as that put forward by Mr. Williams, has held together perfectly *as a coherent theory*, and even partially illustrative by proof, but has at length been obliged to yield to stronger evidence of the *contrary*, by some other and *counter-discovery*, or some more *general view* of the subject, which completely overthrows it, or at least mars it. Such, indeed, has been the case with the various theories respecting the sun; and the spectroscope has at once *overturned* the former theories respecting its supposed habitability, which have been so firmly established in the minds of men, first by Wilson, and subsequently modified by the *Herschels*. Instead of a nucleus protected by a cool stratum of clouds from its upper and

* It is not *altogether* new or original, as the same opinion as to the universal æther pervading space similar to our terrestrial atmosphere, only extended to great tenuity, has been held by others, among whom is Mr. Vaughan, of Cincinnati.

fiery atmosphere surrounding it, we now are obliged to concede this tremendous fact, that the fiery photosphere seen by us is the effect of a metallic molten nucleus beneath. This, it is true, is an instance of the converse case, which Mr. Williams might plead in his favour, in which an old established doctrine is overthrown by a newer; but the opposite may just as probably occur, as indeed has occurred by the revelation of the same wonderful little instrument (the spectroscope): viz., the re-establishment of the elder Herschel's doctrine respecting the *nebulæ*,—that the unresolved *nebulæ* were many of them not firmaments or galaxies of stars, but nebulous matter in different stages of development. This doctrine, which the sagacity of the greatest observer that ever lived had at once and instinctively led him to adopt, was for a time overthrown by the revelations of Lord Rosse's telescope, which being of greater power than any ever constructed before, resolved many *nebulæ* unresolved by Herschel, into systems of stars, and for a time a triumphant overthrow of the elder Herschel's theory, in which La Place's was strangely mixed up afterwards, followed. But the triumph was short-lived. A small instrument that could be held with the hand, completely reversed the case,—overthrew deductions formed from the great telescope,—and the old doctrine is again re-established. It is now demonstrated that there are numerous *nebulæ* that are composed, not of stars or suns, but of nebulous matter; probably the raw material for forming suns and planets.

The conclusions, therefore, founded upon a new theory, however ingenious and plausible, and so far as it has gone, *seeming* to be correct, should be received with great

caution; and the more so, when the very first step in Mr. Williams' theory requires belief in what it is *impossible* for him to *demonstrate*, however probable: viz., the existence of a universal atmosphere diffused through space, and attaching itself to planets in a condensed form, in proportion to their mass and density; or rather, the resultant of all their masses to form atmospheres, although it is true the theory has corresponded in some particulars in a marvellous way with the deductions from telescopic observation, yet it has *not in all*, and a considerable difference is found in the observational conclusions of Mr. Proctor and other eminent astronomers, with Mr. Williams, as to the condition of other planets, Mercury and Mars in particular, where they do not *coincide*.

But returning to the strongest argument adduced by either for the sunlike or incomplete condition of Jupiter, we may acknowledge that its supposed specific gravity is that which is most in favour of it; the *light colour* of its bands, or the visible rapid changes on its surface, which we have already referred to, *may* all, as we have shown, have place consistently with the idea of its being a perfected planet like the earth, and *habitable*, if not inhabited.* But how are we to account for its proportionate

* The remark of Mr. Proctor, that it would be, humanly speaking, impossible that such masses of vapour as are apparent on the surface of Jupiter, could be generated by solar heat alone, which would necessarily be too feeble to vaporize her ocean, has been partly explained already by Professor Tyndale's theory; but while demurring to the hypothesis of an unfinished world and a molten surface on Jupiter as the cause, may not Mr. Proctor adopt a middle course, and if greater heat than our sun could supply be needful, may we not believe that some *surface heat* still remains on the planet, sufficient to assist in the evaporation of her oceans, without rendering it incompatible with life, or rendering necessary a molten surface

lightness of substance? The difference between the respective *masses* of the earth and of Jupiter is considerable. Jupiter's mass, or to speak popularly, *weight*, exceeds that of the earth by not more than 300 times; while in volume or size, he is 1,230 times that of the earth. According, then, to the best estimates of his mass and diameter, the mean density of Jupiter (in other words, his specific gravity) has been ascertained to be less than *one fourth that of the earth*, or greater than the *density of water* (which is assumed as the standard for planetary measurement) by about only *one third*. This is certainly a remarkable feature in the planet,—one, however, which seems to be the effect of some great law pervading the solar system (rather than a sign of incompleteness),—a gradual *increase* of density appearing to belong to the planets for some reason *as they approach the sun*, while a corresponding *decrease* takes place as they *recede*:* the *density* of Saturn, Uranus, and Neptune, it is believed being gradually less than Jupiter; the density of Mars, also, less than the earth; while Venus and Mercury are believed to have a density, the latter especially, much greater than the earth, varying from the comparative lightness of Jupiter: consequently many wild and absurd theories have been started as to his condition,—Dr. Whewell suggesting a dismal world of water and ice, with a cindery nucleus, inhabited by pulpy gelatinous creatures. The *absurdity* of such imaginations and speculations is a sufficient answer to them, and are un-

and a white heat to produce it? It is believed by many that our earth has not yet cooled down, and that a great portion of the warmth we feel is derived from innate terrestrial heat.

* This law is in accordance with La Place's theory.

deserving of a serious reply. Our own world furnishes a sufficient proof, indeed, in the variety and beautiful and perfect *adaptation of creatures* to their true abode, both man and beast.

But Mr. Williams at one blow consigns Jupiter to a permanently and uninhabitable fiery fluid state, when he says, "*There is no kind of matter of which we have any knowledge*, that could form a globe having the dimensions and specific gravity of Jupiter, unless it was heated to a state of fusion." This is bold language, but I cannot but think *hardly* warranted by the facts. Is it then impossible for God to make a *perfect world*,—i.e., perfected world,—and habitable, of different *weight* or specific gravity, or of *different materials*, without *fluidity*? or is the Creator so circumscribed and so bound in His own laws, or rather confined to the laws and the substances which we are acquainted with, that He *cannot* make a planet of a *certain weight* unless it is *made a fluid planet*, or a *half-melted, heated world*? The idea is absurd when you think on it a moment. Of course, if the universe consist in nothing but a system of *rigid and unbending laws*, without a Law-maker, and certain combinations of matter with which we are acquainted, which can never be *deviated from in a single instance*, and have no Master or Ruler to mould them as He pleases, why *men* may *justly* reason up to such conclusions; but if there is an *intelligent and personal Designer*, in whose image he is *himself made*, in a miniature degree (*which is the fact*), then the case is very different, and the infinite variety which we see around us may be extended to the composition of the materials of the great planets, as well as to the fauna and flora, the inhabitants of the

earth, and all its varied productions. Even as man himself loves and makes variety in the materials which he moulds for himself, so may the Almighty Creator. Mere ignorance, therefore, of matter which *could* form a globe of Jupiter's dimension and specific gravity, without the necessity for its being altogether fluid, surely is no proof that there is not or could not be such a globe,—is no proof, I humbly think, that Jupiter must necessarily be a globe of that kind, and could not possibly be solid. As well might we deny the power of the potter to make vessels of different weight and size and cohesion, of the *same* or *different* materials, while we ourselves are ignorant of any but a limited number of materials, or the effect of different proportions of compositions in those materials. In the making of china, for instance, many materials are now used which were unknown before, and many known formerly unknown now; yet the absence or presence, or more or less quantity of a single material, would make a vast difference in the strength and power of cohesion in the china. Many materials, indeed, are used in the manufacture of china, which if left out altogether, or not in proper quantities, would render it impossible to manufacture a vessel of certain dimensions and thickness and proportions, without its falling to pieces on being left in an imperfect and soft condition; but very often the presence of a single important ingredient alters the case wholly, as it does in the vegetable world, where the presence of silica is necessary to enable the corn-stalk to *stand upright*, and resist the strength of the wind. If ignorant of the nature and presence and applications of silica to this purpose, we were *theoretically to reason as to its power* of standing upright and

possessing the strength it has to resist prostration, we should probably come to the erroneous conclusion that *nothing could give it the requisite strength*. So we may say of this distant world. Although we may *weigh it*, distant as it is, and compare it with our own, unless we know positively what the *materials* are of which it is built, and the *proportions* by which it coheres, it would be impossible to pronounce that it *must be* (if it be a certain weight) *in a fluid state*. The high probabilities are indeed quite the other way, and it is much more natural to expect infinite variety in the construction and arrangement of the materials of other worlds, than to expect an identity. The specific gravity of oceans, and the very waters of the earth, differ in this; not to speak of other substances, such as wood and iron. Why may not the specific gravity of worlds? The adoption of water as a standard of measurement for worlds, is no reason for not believing that solid worlds may exist whose specific gravity is far lighter than water, or the *same*, without being water. And thus, I think, we may conclude respecting Jupiter; and I do not agree with Mr. Williams, that the idea of a solid shell enveloping liquid and gaseous matter lighter than itself, which has been suggested and adopted hitherto, "crumbles and melts away at the touch of sound reasoning based upon the established facts of experimental science." And experimental science has not yet proved, and I think never can prove (for it is inadequate to do so) that Jupiter must necessarily be a fluid mass; nor that the Creator in His wisdom may not have given, and indeed probably has given, a different specific gravity to every planet throughout infinity.

Nevertheless, while thus advocating the *possibility*,—let me perhaps rather say *probability*,—of Jupiter being a *completed* world, I should be presumptuous were I to deny, for other reasons, the possibility of what Mr. Proctor so cautiously, and I may add, philosophically suggests, when he asserts, viz., the *possibility* that Jupiter might be an *uncompleted* world, in the sense in which he speaks of it. There must, it is evident, be a beginning to all worlds,—some in every stage, from the foundation advancing *slowly* towards completion; for I do not hold that any world was *built* in a *day* or a *month*. The geological discoveries of our own world's history prove *that*. Therefore in deciding upon the present condition of a planet so far removed from us, the *possibility* must always be allowed, that as the former probable fluidity and heated condition of our globe is apparent, and millions of ages probably elapsed at least before Adamite man appeared on its surface, so it is possible may be the case with our giant companion planet, which may not yet have arrived at a state or condition fit for being inhabited. This is *possible*, but I cannot but think, with Dr. Lardner, highly improbable. One thing is certain,—presenting as Jupiter does to us a miniature representation of our solar system, he must, whatever his condition, be *the centre of a system of worlds*; and as such, whether he be inhabited or not, he presents a subject of the deepest interest, well worth our attention.

If Jupiter be a sun himself, it is plain he will be so only for a time, and his condition will not be in any way analogous to our sun, for which no such future seems to be reserved. The condition of Jupiter, even if he be as the astronomers I have referred to believe, but a molten

or a fluid mass, can only be a preparatory one. The earth was once the same, and what is she now? "I have formed the earth," saith the Almighty, "to be inhabited;" and doubtless so He has the great globe of Jupiter. The grandeur of his position in our system, the very sight of his four moons moving round him, suggest almost instinctively to the mind that they *are* what they *seem* to be,—not mere useless appendages,—not there even for their own sakes, as independent planets,—but that He who placed them where they are, and arranged every movement of their course, doubtless contemplated the effect of every eclipse and every transit, did so with a special design. And what was that design? If it could be *demonstrated* that Jupiter was no more than a sun, further speculation would be useless, and they would not be satellites; but to prove this at the distance at which he is situated from us is impossible. Nor does Mr. Proctor even assert that he is a sun: steering between difficulties, he only suggests his being an immatured planet. It may be well questioned, however, whether it is probable. That the sun and Jupiter may go halves, as it might be said, or share in producing light for the Jovian satellites, is most improbable. There is no such precedent in the entire solar system, in reference to the other planets belonging to our solar family. A supplementary light from a planet to its satellite, and originating in itself, would be a confession of the sun's inability to do the work for which he was made, and a kind of patch-work interpretation of the condition of the great primary, for which there does not appear to be any analogy in the heavens; but on the contrary, a departure from the general law found there—that a *sun* is a *sun*, and a *planet* is a *planet*.

The compensating system is quite different, and relates merely to the supply of night illumination by reflection. The distinction of the separate functions of sun, moon, and planets, is indeed very clearly defined in Genesis, where the sun is represented as to *rule* the *day*, and the moon (it may be presumed therefore *all moons*) to *rule* the *night*; not *be ruled* themselves. Thus viewed, what is the design which seems to be apparent in the satellites of this great planet? It is evident that his moons are *intended* to be to Jupiter what our moon is to *us*, and *was* to us even in our immatured condition: viz., the regulators of his oceans, and the illuminators of his nights. Where there are oceans there will be tides. The moons of Jupiter are therefore absolute indicators of the existence of oceans and tides on his surface, of which they are the regulators. They are as four fingers pointing our attention to this great fact. They are as four voices calling to our "listening earth," and saying, "We are *four* moons to your *one*, because our primary is so far removed from the sun, that no tidal influence can be exercised upon him from that body, and the grand oceans of our primary need more than fourfold the power of your solitary moon to control them. Then, "We are four lamps," they cry,—*"four to your one; for think what a vast country we have to traverse and enlighten, and remember how little sunlight beams upon our great planet compared to what you receive, and how short his days,—even the shortest winter day on earth (a day of five hours) is all the daylight our great centre enjoys, until our fourfold light appears, now in succession, now altogether, making insensibly a mixed day of ten hours of varied light, as we take the place of the departing sun."*

Indeed, the first glance at this noble planet impresses the beholder, as it did Galileo, and many a follower of his creed since, with the conviction of direct design and agency perceptible in the four beautiful stars that illumine his surface and charm our sight.

That the condition of the inhabitants of Jupiter indeed must be widely different from our own, is at once apparent. The shortness of their days and nights, and the peculiarity of their seasons, resulting from the position of the planet's axis at right angles nearly to the plane of his orbit, the enormous length of his years, with solar and lunar phænomena so different from our's, combined with the vast size of the world they inhabit, and the probable proportional size of its oceans and mountains, rivers, etc.,—all this causes so complete a distinction from anything that we know here, or might experience in other planets, such as Mars or Venus, that we can form little or no conception of the country or its inhabitants. What mysteries lie hid beneath the lovely veil of its cloud-covered surface we know not, nor probably ever shall,—in this world, at least. Meantime there is nothing in his *seasons*, his days or his nights, to prevent that vast globe from being, for aught we know, a perfect paradise. The inclination of his axis will give a modified climate,—a perpetual spring or autumn, merging into summer over the equator and the regions adjacent. No long, cold, dreary nights will be found there, to chill his atmosphere into frost. Bright diamond-like moons, some of them twice the size of our's, succeeding each other with a motion so rapid that it can be seen, will chase each other across his heavens, pouring their single or united light upon every point of his

surface, while cloud-colours of every hue will decorate his heavens.

In bidding farewell to this noble planet, it is impossible not to consider him as *one* (and *that* not the least) of those bright mansions in the Father's house spoken of by our Lord, prepared, or to be prepared, for those who know and love Him, when with spiritual bodies that shall be independent of all the powers of gravity, they may defy his stupendous mass to chain them to his surface, or prevent their flight and visit to other worlds, or from roaming unfettered with the speed of light through his own wondrous regions, to hear the thunder of his oceans, and gaze upon the sublime scenery of his giant mountains, and to enjoy the variety to be found in a world to which our own globe appears but as a grain of sand in the universe of God.

SATURN.

ANOTHER flight of 500 millions of miles brings us to perhaps the most wonderful of all the objects in the heavens. Saturn, whose complicated ring system, so long an enigma to Galileo and others, in the era of imperfect telescopes, now presents to the wondering eye of the modern astronomer a sight which fills the mind with astonishment and admiration, mingled with a burning desire to know more respecting this strange ringed world, and the phænomena connected with its condition. Never shall I forget the impression made upon my mind at the first sight I obtained of it: a meeting as unexpected as it was delightful. It was many years ago, when but a tyro in astronomical knowledge,

and an inexperienced, though enthusiastic searcher of the heavens. I had constructed a common refractor of considerable dimensions, having an object glass six inches in diameter, and ten feet six inches focus. I had never seen Saturn, nor any of the planets with any telescope, although I had of course read of them in books, and seen plates of them; but I did not know where even to look for them, nor how to distinguish them from the fixed stars, or from one another, except that I knew the fixed stars sparkled, and the planets gave a steady light, which I had observed with the naked eye. On the night in question, I had placed my large refractor upon the upper sash of my parlour window, and was endeavouring to bring under my view each star that was most conspicuous, when covering a dull silvery-looking star, with my object glass reduced in size by a diaphragm to about an inch in diameter, and a power of 120, I beheld a sight at which I started; and though alone, I exclaimed aloud with astonishment and delight. I had actually before me in the heavens the ringed world of which I had so often read and seen plates. There gleamed its wondrous ring and stately globe, shining in the calm summer sky with a subdued silvery splendour. My sensations as I gazed at the mysterious object, were indescribable. That *ring*,—what *could* it be? That silvery shining globe, two of whose glittering satellites are likewise present,—how strange its condition; how unlike anything else I had ever seen in the heavens! I could not take my eyes off this ghostly object. I gazed again and again, till my eyes ached, and its ringed impression remained on my retina long after I had withdrawn it from the telescope. I applied a higher power (240), and

could now see distinctly, as I thought, the shadow of the ring on the planet, and the planet on the ring; also what at the time seemed to be a strange star shining between the ring and the planet. I have never seen this since, nor can I now say what it was. I had read in some book, however, that stars were occasionally seen peeping between the planet and its ring, and I concluded at the time that what I saw must be this phenomenon. But I am more doubtful now that it was; in fact, I cannot conjecture *what* it was. But the impression remains distinctly on my mind, that I had seen something resembling a star between the ring and the planet. It became clouded soon after, I had therefore no opportunity of further observation that night; but I can truly say that that chance glimpse of Saturn fixed indelibly for ever in my mind the determination to follow up the delightful and absorbing study of the science which has proved such a solace and companion, such a recreation and source of the purest pleasure, through a life of no short duration.*

Saturn is another giant planet, and without the appendage of its ring little inferior in magnitude to Jupiter. With an equatorial diameter of 74,700 miles, and a bulk 700 times that of the earth, and a ring, or rather a system of rings, embracing a circumference around it of not less than 528,000 miles, escorted by a brilliant train of eight satellites, it presents perhaps the grandest, and certainly the most wonderful of all the

* By a curious coincidence, Mr. Proctor himself attributes to the first glimpse he had of Saturn, his entrance upon, and subsequent devotion to the noble science to which he has devoted himself, with an earnestness which can only be equalled by the ability which he has shown.

planetary objects in the heavens, constituting in itself a gigantic and complete system of worlds, with their centre, before which our own little globe dwindles to a speck in creation. Yet in point of mass and density, Saturn is greatly inferior to Jupiter. The latter outweighs the earth 300 times; while Saturn, notwithstanding the great disproportion of its size to the earth, is only 90 times as heavy. This would leave the substance of which this huge planet is composed, whatever it be, as light nearly as cork; its mean density being not more than half that of Jupiter, and three-fourths that of water, thus specifically lighter than any known planet.

The Saturnian year occupies nearly thirty terrestrial years; while his enormous distance from the sun (950,000,000 miles), being twice the distance of Jupiter, and ten times the distance of the earth from the source of light and heat, leaves to him but about the hundredth part of light and heat enjoyed by the earth: *i.e.*, on the supposition that there are no exceptional circumstances which may alter or modify these conditions. His orbit being excentric, however, the amount of light and heat which he will receive will vary with his proximity to the sun at the time.

Saturn differs likewise from his companion giant by his axis being $28\frac{1}{2}^{\circ}$ inclined to the plane of his orbit, which would give him a greater variety of seasonal changes dispersed over his globe than is the case in Jupiter, where his axis is all but perpendicular to his orbit.

With reference to the condition of this planet as an inhabited world, derived from his position in the solar system, all that has been said of Jupiter applies to him with additional force, as to the consequences of receiving

so small a measure of what are considered by us as essentials for the maintenance of life,—light and heat. If there is insufficient light and heat in Jupiter to render it habitable, then the case is much worse in his companion world. The comparative obscurity of Jupiter would in Saturn be all but *darkness*; and the small modicum of solar heat received by the former, would be in the latter reduced to something almost as insensible to feeling as the heat we derive from the reflective rays of moonlight, or that of the stars.

Thus, arguing upon the principles put forward by Mr. Proctor and others, either Saturn is an *arctic planet*, sealed up in perpetual ice, frost, and gloom, or, according to the new hypothesis, the *reverse*, and itself an intensely heated and fluid globe, hardly, yet in even a fluid state, but rather gaseous, and giving out its own light and heat to its satellites, whose inhabitants (if any) acknowledge him as their sun, while they actually see their real great central orb as a *twinkling star*.

It is unnecessary here to repeat again the arguments we have used in opposition to *both* these *hypotheses* in the case of Jupiter. All that has been said respecting that planetary world may safely be repeated respecting *this*, his companion, situated on the confines of the system, or of what we at least supposed at one time to be so. If inhabitants are to be excluded from Jupiter (*a fortiori*), they should be excluded from Saturn; and certainly inhabitants resembling ourselves physically, must be excluded from both. But in my opinion, from *neither* are we warranted as yet in excluding life and intelligence in some form; and the very same arrangements which would make one globe fit for such a purpose (not-

withstanding appearances), would be applicable to the other.

Certainly at the first glance at this ringed world through a telescope, and with a knowledge of its *astronomical condition* (for of its *physical* condition we absolutely know nothing), if there is anything indicating that it is possible that Jupiter be inhabited, then (*a fortiori*) it is equally possible that Saturn is; nay, the possibility, or rather probability, is greater in the latter case. Its vast size, and the complexity of its system, impresses one with a conviction of its importance in the system to which it belongs; while the peculiar and beautiful compensating arrangement for lighting and regulating it, exceed that of its brother planet in the proportion which might be expected from the disadvantages of its distance from the sun.

It is to no purpose that Mr. Proctor tells us that *well-meaning persons, who insist on their own* interpretation of the Almighty's design, are singularly "unsuccessful here in overlooking obvious difficulties, for that in the case of Saturn, as in the case of Jupiter, the provision of satellites, and of the ring, which form so glorious an object to the astronomers on earth, is altogether inadequate to increase the supply of light received by the Saturnians to any such extent as has been imagined," for that in point of fact the *rings keep away more light from Saturn* than they give, causing frequent and long eclipses. If, therefore, compensating light was intended, it would argue want of wisdom in the selection of such an arrangement. Now as to any one *insisting on their own* interpretation upon the Almighty's designs, while we overlook the real difficulties that oppose such interpre-

tation, no one could defend it; but let me here say, with the deepest respect for this very able and accomplished writer who thus expresses himself, I think, as a theologian, any person may very fairly be permitted to interpret the Almighty's *general designs* from what he sees, without any presumption, even though he may be unable to explain many difficulties. Nay, I think in a world where proofs of design surround us on every side, and difficulties too, we may fairly accept and interpret the *general and evident design*, even though we cannot overcome all the difficulties; nay, I cannot but think we are *called upon* to interpret them so far as *we can*, and very often it so happens that when we *do interpret* those proofs given, and *correctly* too, so that there can be no doubt upon the subject, we are often met by apparently opposing circumstances, which yet are unable to *overthrow* the general truth of the interpretation we have adopted, and are obliged ultimately to yield to it.

Thus we may argue fearlessly, without question, as to the benevolence of the Deity from design, and yet what a host of particular circumstances and facts in our condition here and in nature, seem to oppose it! Yet *who* that has really studied the subject, doubts the goodness and benevolence of God, notwithstanding the very few facts which seem to oppose it? So an anatomist may reason from a *nerve* or a *muscle* or a *gland*, and interpret the design for their formation without being questioned, although there may be many things connected with his interpretation which may *seem* to be opposed to it; so also a botanist may interpret design from a flower, a geologist from a stone, without incurring the charge of presumption or misinterpretation because *every circum-*

stance attending their interpretation does not *coincide*. The things they interpret *from* are things they *see*, and their interpretation is the result of what they have learned about them; and in such cases, generally reveals the design as plainly as if God Himself, or an angel had whispered it into their ears. Generally, indeed, the interpretation of design lies upon the surface, and by an intuitive effort the *mind grasps* it at once, without waiting for indicative proofs; while, on the other hand, the acquisition of facts is *slow* and *laborious*, and after all *by no means certain*. Thus the geologist may and does fairly argue the design in the formation of *coal* in our globe; while there are not wanting many who are prepared to prove, by incontestable fact, there was *no design intended*, and will bring an army of evidence to show that it was not the case.

But here there can be no doubt, the existence of planetary worlds, once ascertained and compared with our own, the lighting and regulating of those worlds by satellites, is a thing *patent to all to interpret*, and doubtless was so intended. There is no semblance here of a necessary admission into the deep counsels of the Almighty, in saying yonder planet is certainly lighted by so many moons to compensate for its distance from the sun.

But what are the arguments brought forward to prove that those who maintain the compensating principle of lighting the planets are wrong in their interpretation? Nothing but observation with a telescope, of a world situated at a thousand millions of miles from us, and the supposition (for it can amount to little more) of the probable effects produced in that world by the ring and

satellites,—effects which however plausible, I maintain it would be very hard, if not impossible to demonstrate, unless *we were there*. For my own part, I would much rather trust to the general design apparent in that distant world, than to any observation of *details* in the distribution of it which would seem to militate against it. Difference of opinion already exists as to the apportionment of light in Saturn, through the intervention of the ring, which has not yet been definitely settled by astronomers. Meantime let us look at this wonderful appendage, the nature of which, indeed, we know so little of, that it would not be easy to pronounce anything certain as to the effects of it on the world it encircles, any more than its nature. Its size, as already remarked, is stupendous, and its position *strange*, exciting many speculations and theories in the early stage of its discovery,—theories which still exist in different forms in many minds, and which even modern research, with all its aids, has not been able to determine.

A vast ring encircling a globe of such a size without touching it anywhere, is a wonderful object. *How* came it there, and *why*? and if so, of what is it composed? are questions that mentally occur to the beholder. I have never met with any hypothesis that fully satisfied my own mind on the subject. Both the Herschels considered the ring (or rather *rings*, for there are many now perceptible) *solid*, at least as solid as the planet; but that hypothesis has been now given up. The multiform divisions of the ring, and the discovery of the black gauze interior ring, generally transparent like a veil, next the planet, and which can be seen through it, appearing suddenly, as if it was a *new creation*, only discovered

within a few years back, and never by the elder Herschel, this served to reduce the hypothesis from a solid to a fluid, or a *gaseous substance*. That it shines with *reflected light*, is *certain*; that it has a revolution round the planet, is also conjectured; that it consists of many consecutive rings, is also *perceptible*; that many variable shades and markings are apparent on it to good telescopes, is also certain; that it casts its shadow on the globe, and the globe on it, is also evident; but what its nature is, is still a problem, still *unknown*, and probably will be for ever.

The last hypothesis, that of Mr. Maxwell, the author of the Cambridge Prize Essay on the subject in 1857, makes it to consist of *innumerable separate planetary bodies* revolving round it: "A dense flight of satellites, so closely grouped as to escape individual recognition at our great distance, yet revolving each in its separate orbit, in such a manner as to secure the genuine permanency of the system,"—which he and some others say they have detected as composing it. This opinion is considered to be (as it *is* the most recent) the most probable, and yet it has not been *demonstrated*, and remains still in the regions of uncertainty. The aspect of the ring in a telescope produces quite a different impression: viz., that of solidity,—an impression confirmed by the respective shadows of the ball and the ring, which are cast partially upon each other, and which can hardly be reconciled with the supposition of a congregation of separate *ærolites*, or planetary bodies. Mr. Maxwell, however, asserts that the thinness of the ring alone would disprove the possibility of its solidity, as being at the utmost but 100 miles in thickness, or according to Mr.

Bond, but 40. This, with the fact of its breadth of 28,000 miles,—this would (says Mr. Maxwell), under the forces it experiences, render it not only *plastic*, but *semi-fluid*, even if it were made of *iron*.

Meantime some of the American astronomers preferred the hypothesis of its consisting of a number of streams of a fluid a little denser than water; and others, again, with perhaps even more probability, that it is of a vaporous nature. "The fact is," says an able writer in the *Intellectual Observer*, "we think it would be readily admitted as such by those who have most closely examined that object, that it is extremely difficult to form any idea of its real nature *from observation*; and so long as that is the case, it offers a wide field for the admission of dissimilar theories."

Be it what it may, however, as to the materials of which it is composed, the main *object* and *design* in its existence *where it is*, is I think plainly perceptible, and shines out through the cloud of the uncertain theories as to its *nature* and *constitution*, with a clearness that is in strong contrast to them: viz., that it is placed there as a supplemental mode of lighting that distant world, the position of which is such as to require aid to accomplish that purpose, even to the eight satellites that surround it. Doubtless there may be other purposes likewise subserved by this wonderful appendage (should it have solidity), similar to those which are performed for this earth by our moon, such as the regulation of the Saturnian tides; but so long as the nature and quality of the ring remains unproved, there is but the one great purpose which is *evident*, which can be seen and learned, even to *demonstration*: its being a light reflector to the

great planet it surrounds, which can be affirmed as certain.

Nor would its being composed of separate *ærolites* affect this question. On the contrary, such a supposition would perhaps remove some of the objections advanced against a solid ring as a permanent light reflector, Sir W. Herschel stating, notwithstanding his belief in the habitability of Saturn, that his rings would occasion an eclipse of nearly fifteen years in duration, first to the northern and then to the southern hemispheres,—a theory opposed by Dr. Lardner on mathematical grounds, who yet acknowledges considerable eclipses produced by it. Both these theories are equally objected to by Mr. Proctor, who yet does not mend the matter as regards the effects produced by the ring, when he says, on grounds obtained by the most exact mathematical calculation, that in Saturnian latitudes corresponding to London or Paris, the sun would be totally eclipsed by the ring for *five years in succession*, while in the latitude corresponding to Madrid, he would be eclipsed for *nearly seven years in succession*; an arrangement which he justly affirms, "the inhabitants of the earth would find wholly unendurable,—an arrangement, too, which prevails over a very large proportion of Saturn's surface." These calculations, however, be it remembered, are made on the presumption of the continuous solidity of the *ring*, which as a dense body would undoubtedly produce the effects described by these astronomers, more or less; but the case would be altered were the ring light-giving on *every* side, below as outwardly,—either *through transparency*, light passing through it as a cloud or as *glass*, or from being *self-luminous throughout*, or, as in the case of

the separate meteorites, if not self-luminous, yet shining with a twofold *reflection* from the sun and from the primary, but in all cases presenting an illuminated surface to their primary. Thus, perhaps, all eclipses may be prevented.

Such speculations, however, as already remarked, must be to a certain extent *guess-work*, as at the enormous distance it is from the earth, observation of such matters is all but useless, and the general scheme alone *can* be *seized upon*, which is sufficiently evident, and only requires *faith* in respect of what cannot be positively discovered, to believe that the main intention and purpose-principle will be carried out. Assuredly that glorious ring and satellites will fully compensate to the inhabitants of that wonderful globe, as far as light is concerned, for its vast distance from the sun.

There is only one circumstance more in relation to this planet, which it will be necessary to remark upon, which is adduced by Mr. Proctor as conclusive of Saturn being a minor sun, and therefore for the present uninhabitable: *i.e.*, a certain mysterious change of figure, or distortion, which has been observed occasionally in the globe of Saturn by different astronomers, and has been called the square-shouldered figure. This peculiarity was first remarked by Sir W. Herschel, in April, 1805. On that occasion the usually elliptic form of the planet was strangely distorted; both *equator* and *poles* appeared *flattened*, so as to give an *oblong square* shape to the globe, only at the angles rounded. So remarkable was the appearance on this occasion, that Herschel measured it accurately, and found the longest diameters (having their extremities in Saturnian latitude) $43^{\circ}20'$. His first

impression naturally was that it was distorted through the telescope, but the same effect was perceptible in several different instruments. What could it be? The only other alternative was either atmospheric disturbance in *our* heavens or the Saturnian heavens, or the Saturnian globe itself; or possibly an optical illusion, depending on the persons themselves. Which of these was the most likely? It is plain that Herschel attached little or no importance to it, as no suggestion whatever appears in his writings to account for it. Probably he attributed it to some optical illusion, but certainly never hinted at the possibility of such an astronomical conclusion as some modern astronomers are prepared to admit,—that it was a vast convulsion of the entire globe, labouring under throes of violent internal agitation like those of our sun.*

But Herschel is not the only observer of this phenomenon. Schröeter, in 1803, Kitchener, in 1818, and Airey, on one occasion observed the same oblong square-shouldered appearance, while upon another occasion the same eminent astronomers observed the very *reverse* case, and the planet appeared flattened at the poles only. Bond, of the United States, also has seen it. Now it is upon these occasional strange distortions of figure that Mr. Proctor argues to the startling conclusion that the very body of Saturn itself is subject to the influence of forces so violent as either to upheave portions of its

* It is remarkable, and worthy of notice, that tremendous as we *know* the forces in action in our solar orb are, yet not the slightest appearance of any change of figure or distortion is visible in that globe; the only apparent change in it being that produced by the refraction of our dense atmosphere at sunset, when its usually spherical form becomes *oval*, or the poles are flattened.

actual surface, or cause vast masses of cloud to rise to an enormous height above the mean layer of Saturn's cloud envelope.

Now, setting aside the fact that the eminent astronomers who have seen this strange distortion have none of them attempted to account for it thus, but on the contrary have dismissed it as an optical illusion, curious perhaps, but of no importance, I cannot but agree with Mr. Proctor himself, that such a conclusion as that suggested by him is to be avoided if we can by any possibility find a less startling explanation of the matter; and I think there need be little difficulty in referring the distortions to the terrestrial atmosphere, if not to personal causes connected with the state of the eye at the time. Either would be quite sufficient to account for it, without convulsing the usually tranquil globe of Saturn, a globe of 74,000 miles in diameter, as one would squeeze a soft orange out of shape, for the sake of carrying out a particular *theory*. Surely we have often seen the identical distortion referred to produced by a bad or imperfect pane of glass in a window, by which landscapes, and trees, and houses, and ships, and men themselves, and the face, are *elongated*, or the *reverse*; and we have only to consider a portion of our atmosphere the *glass* or pane on the great window of heaven,—*i.e.*, a particular portion of the atmosphere at the time lying directly between the observer and the planet,—as being in the condition of the pane of glass, distorted and imperfect, while from other points of sight all is clear and correct, and the thing is done—all is explained. An observer at Greenwich is looking at Saturn with his *square shoulders*, with wonder and amazement; while another at the Cape, or

some other geographical point of observation, is looking at the same object, and sees nothing of the kind. The telescopes may be fully *acquitted*, for they will all of course bear the same testimony from the same point of sight; but it is our atmosphere that is to blame, and the evident *contortion* viewed is owing to it, and it alone. The planet is unconscious, and innocent of it.

But Jupiter is called in to bear his testimony to the same fact, in another way; but, as I take it, not with more success than his heathen father. Mr. Proctor refers to an observation of Admiral Smyth,—that on one occasion the second satellite of Jupiter, twelve minutes after entering on the disc of the planet (a transit), was seen *outside the limb*, and then utterly vanished. Two other observers, it is said (Messrs. Maclear and Pearson), witnessed the same phenomenon. "Here," says Mr. Webb (and truly, perhaps), "explanation seems set at defiance." In this, however, Mr. Proctor does not agree (nor I either), for he says, "The explanation may be expected to be surprising, but I think it is not far to seek. The satellite cannot have retraced its course, Jupiter cannot have shifted his place, our atmosphere cannot be in question. Surely, when all these explanations are eliminated, our task is rendered easier instead of more difficult; a change of shape in Jupiter corresponding to that which I have endeavoured to exhibit, as explaining Saturn's occasional assumption of the square-shouldered aspect, would obviously account for the phenomenon. We know that Schræter suspected an apparent flattening of Jupiter's outline: now we have an effective confirmation of that long-doubted observation." Mr. Proctor will excuse me if I am still

inclined to leave this observation of Schröeter's among the things that are more than doubtful: nor, even if his observation was correct, can I believe that the strange phenomenon witnessed by Messrs. Smyth, Maclear, and Pearson, is a satisfactory solution of it, on the hypothesis advanced by Mr. Proctor; what these eminent observers saw, it seems to me, can as easily be explained as the square-shouldered aspect of Saturn, only in a different way. In the case of Saturn the solution of the phenomenon will probably be found, as already remarked, in the partial disturbance of a portion of our atmosphere. In that of Jupiter, I should be disposed to refer it to partly *atmospheric* and partly *personal causes*; and the remarkable effect of the satellite's apparent retrograde motion chiefly to a sensitive retina,—an effect which I have myself personally experienced. Thus: we suppose the observer, with his eye at the telescope steadily fixed, observing the transit of Jupiter's second satellite referred to. The observation of a transit is, be it remembered, by no means an easy thing: it requires a *good* telescope, a keen sight, and a clear, undisturbed atmosphere. The eye is fixed on the satellite as a small bright spot, like a very small bright star, or it may be a *black* spot; for this curious and as yet unaccountable difference sometimes occurs in the appearance of a satellite's transit over the disc of Jupiter. Whichever it be, however (say a bright spot, which is the most usual appearance), the eye remember has been intently fixed on it as it approaches, and then enters, and passes for twelve minutes across the belted disc of the great planet. "Suddenly," says Mr. Proctor, "it vanishes; and the next moment it is seen outside the

limb of the planet altogether, where it remains for four minutes and then again vanishes." Whether it reappeared again and continued its course across the former disc, we are not informed; and a good deal of light might perhaps be thrown upon this phenomenon, if we had been told what became of the satellite afterwards; but we are not: whether it came back as suddenly to its original place and continued its course, or made a second entry upon the limb of the planet, or disappeared for the night. But leaving this all unaccounted for, let us see if what is recorded as having been *actually seen* can be accounted for without resorting to the gigantic collapse of the planet itself, like a soft india-rubber ball, or its atmosphere,—so great; as to throw the tiny satellite apparently off the disc altogether; which, it would appear, is the somewhat astounding explanation which Mr. Proctor suggests.*

Now, let us remember the eye of the observer is fixed on the little bright star-like spot for twelve minutes, passing slowly across the golden disc. That period of intense watchfulness is surely quite sufficient to impress upon ordinarily sensitive retina, unconsciously to them, a perfect image of the satellite. But suppose at this critical moment a disturbance takes place in the atmosphere between the observer and the planet, such

* Mr. Proctor does not say whether any measurement was immediately made of the equatorial diameter of Jupiter by the three gentlemen, or any one of them, who saw this phenomenon. Had this been done, and the diameter found to proportionately diminish, there would have been at least *some* reason for the explanation of the phenomenon suggested, as not impossible; but it is not probable that such an explanation of what they saw had occurred to the observers, who naturally referred it to an optical illusion.

as is common and well-known by astronomers to destroy definition, or hide altogether a faint small object like the second satellite of Jupiter, which is the smallest of the four. The satellite instantly disappears from view. "It is gone!" says the observer, removing his eye from the telescope, or not,—as the case may be, for it is not material. "How strange!" "Not at all," says his companion at his side. "Let me look! Yes: it is quite a common occurrence. Some thin misty cloud high up obscures it for awhile; but you will see it again directly." The observer again looks, and his eye now for a moment has wandered from the disc; for, lo, *outside it there it is* again, as though it had gone *backwards* instead of *forwards*! Now, is not this plainly attributable to the impression on the sensitive retina,—retained, as such impressions frequently are, for *several minutes*,—and become visible again in a place where it would be more likely to be seen: viz., on the *dark ground* of the heavens, *outside the planet*, than in the bright groundwork of its disc. But what follows? after four minutes it vanishes again; and so vanishes every delusive image *retained for a while on the retina*, and photographed there; but as the photograph itself when unfixed disappears in the sunlight, so the optic nerve can only retain the image for a limited period, when it too becomes as though it never had been.

Now, all this explanation is not imaginary, but the result of the actual personal experience of the writer; and affords, as I conceive, a simple, and to me satisfactory, solution of an otherwise inexplicable sight. I myself beheld, many years ago, the disc of the great Jupiter himself pass apparently in *front of the moon*

instead of behind it. I saw it as distinctly as I saw the moon itself. I took away my eye from the telescope in *astonishment*. A friend at hand looked; but no appearance of it to him. It had plainly passed behind the moon; or rather, the moon had covered it. Again I looked: there it was, still on the face of the moon,—a *little fainter*, it is true, but still distinctly visible. "*It is there still!*" I exclaimed. "Impossible!" cried every one. And several witnesses now looked successively; but all alike concurred in scouting the idea, and referred it (rightly, as I think) to *myself as the cause*, or *rather* to my eyes. In fact, my optic nerve was the traitor. But does any one doubt the continuance of an image so long on the retina? Let them try the experiment. Let them fix their eyes on a diamond-paned window in a church for about half a minute; then close the eyes, and turn the head in a different direction, and *watch*. By degrees, for it *comes very slowly*, the window will appear perfect, as though it were photographed, only of course as a *negative*: the panes black, the sashes light. Brighter and brighter it gets, though now perhaps you are looking towards the pulpit. At length it reaches a climax of brightness; and then gradually, very gradually, fades, and at length *vanishes*. The same effect can be produced without closing the eyes,—by turning the head to a somewhat darkened or partially-illuminated wall; when every diamond pane will be conspicuous there, and last for *several minutes*, when it *vanishes*. The image will remain on the retina a considerable time without consciousness of it on your part, until you fix your eyes upon a particular spot, and give it *time to render itself visible*; for the forming of

the picture is a gradual *process, not immediate*. A *partially*-illuminated wall is most favourable for it: if too bright, it will not be seen, or *very faintly*. Thus doubtless occur such astronomical illusions as Mr. Proctor refers to; but as to such sights being produced by actual physical *convulsion* in the planetary bodies, I for one am *sceptical*.

Without therefore impugning the importance of the very able analysis of Saturn's condition by Mr. Proctor, or wishing to depreciate the interest derived from all such inquiries, nor to dogmatize upon the designs of the Almighty in reference to such questions,—I am unable for the present, and until more conclusive evidence is afforded of it, to coincide with the opinion that Saturn is a minor sun, any more than his companion giant Jupiter. But I hold that the probabilities are more in favour of the doctrine held by the greatest of astronomers that ever lived,—that Saturn is one of the many illuminated palaces of God that are tenanted by the noblest of God's creatures,—a resplendent habitation, whose coronet of circling glory supplements the want of the *light* of a distant sun; while its brilliant satellites, winding their glittering way through the complex mechanism of that brilliant and beautiful system, so as to enlighten each part of their mighty centre *when they are required*, either in succession or together, proclaim that Saturn's globe, whatever be its present condition, is at all events designed for future glory; not the glory of a *flaming*, red-hot, molten sun; but of a glory that exceeds *that*,—a glory that belongs to it as an habitation for immortal *minds* and *intelligence*,—a habitation meet for those bright creatures that have occasionally

lightened the earth with their own glory. But here we bid this splendid mansion farewell; and away to still more distant regions we steer our course. His brilliant silvery *ball* and circling ring grow faint and dim as we speed on our way towards the confines of our solar system, —*Uranus* and *Neptune* our goal.*

URANUS AND NEPTUNE.

THESE planets have been justly named the Arctic Planets, in reference to their vast distance from the sun, the great source of heat, but an almost infinitesimal quantity of which can be supposed to reach them. They may thus fairly be classed together; for great as is the distance of Uranus from the solar centre, Neptune is so much further, that as regards solar heat† there could be

* See Appendix: end of Second Heaven. (Satellites of Jupiter.)

† Mr. Proctor, in calculating the amount of heat received by planets, limits it exclusively to that which is derived from the sun. The sun is, however (as he is probably aware), not the only source from whence heat is derived by the planets. The combined heat from radiation of the stars (which are themselves suns, many of them probably much greater than our own) constitutes no inconsiderable portion of the heat they receive from space. While it is true that the heat radiated by a single star is inappreciable by us, it is not so when a vast number are combined; and M. Pouillet, by the most elaborate experiments, has proved that the total quantity of heat received annually by the earth from sun and stars, is such as would liquify a spherical shell of ice 185 feet thick, of which 100 feet are due to the sun, and 85 feet to the heat which emanates from the stellar universe. The fact that the celestial spaces thus supply very little less heat than the sun annually, may appear strange when the very low temperature of these spaces is considered. It must however be remembered that while the space from which the solar radiation emanates is only that part of the firmament occupied by the disc of the sun, that from which the celestial or starry radiation proceeds is the entire celestial sphere, the area of which is about 5,000,000 times greater than the solar disc. It will cease therefore to create surprise that the collective effect of an area so extensive should be

but little *appreciable difference* in their condition in this respect. And although *almost* exclusively telescopic planets,—shadowy spectral objects on the very confines, probably, of our solar system,—and probably the last that are subject to the gigantic and tremendous power of solar gravity; *yet* their importance as members of the solar system is not diminished thereby; for, compared to ourselves and our planetary habitation, they are of a race of *giants*, as we are of *dwarfs*, not bigger than a *small* moon to them; while the very circumstance of their belonging to our system *at all*, at *such a distance*, invests them with a strange and wild interest,—exciting our curiosity only the more because we cannot span the enormous gulf that separates us, or know anything about *their physical condition*; while their *astronomical condition* bespeaks at once, notwithstanding the apparent dissimilarity of their position in our system,—an *importance* and *grandeur* far exceeding our own,—not only by reason of their huge size, but the number of satellites or moons attending them.

The distance of Uranus beyond Saturn is, in round numbers say, *two thousand millions* of miles from the sun,—*i.e.*, about double the distance of *Saturn* from the *solar centre*; so that while *Saturn* is separated from *Jupiter* by 500 millions of miles, a gulf of space *twice* that distance has to be crossed from the ringed planet in order to reach Uranus: while to reach the *outer planet* Neptune, a gulf of another thousand millions of miles

little short of that of the sun. This is an important item in calculating the temperatures of planets enjoying but little solar heat compared to others. The neighbourhood of such planets to dense clusters and crowds of stars, would possibly in some measure compensate for the lack of solar heat.

has to be crossed,—giving Neptune a radius of 3,000 millions of miles to the sun, or an orbit of 6,000 millions of miles *in diameter*. These distances are only expressed in round numbers, as the real measured distance would probably be somewhat less; but in a *popular description* a better general idea of the distance is conveyed in *whole numbers* than in *broken* or *fractional portions*; while more or less uncertainty as to the *real* or *mean* distance must prevail. *Such distances*, however, although perfectly inconceivable to us, convey a stupendous idea of *solar gravity*, which can stretch its wide arm from the sun, and grasp a body 37,000 miles in diameter and 3,000 millions of miles from his surface or centre, and *hold it fast*, and control its every movement; while the vast size of these two planets, and their social connection with us as one of the solar family, prevents us from looking with indifference at them. We must acknowledge them as *belonging to us* in a certain degree; and view them, probably, as the members of a family circle *here* might regard two other members whose lives were passed in *Australia*, or the other side of our own globe, and of whose history and doings we had but scanty *information*. Still the *tie* remains,—the feeling that they are one of *us*. So Uranus and Neptune belong to us; are planets, like ourselves; and belong to the same solar head. But in truth when we come to look at these planets, there is little to be said of them, for there is little known; and the most interesting part of their history will be found in their being discovered *at all*. Uranus was discovered by Sir William Herschel on the 13th March, 1781, at Slough, near Windsor. While engaged examining the stars in Gemini he was

struck by this star, the diameter of which changed as he applied different power to the telescope, which is not the case with the fixed stars. This induced him to watch if there was any perceptible motion in it, and soon discovered a visible motion by measurement of its distance from the neighbouring stars. His first impression then was that it was a comet; but subsequent investigation by himself and other eminent astronomers revealed the fact that it was a planet, which followed like its companions regularly in the signs of the zodiac. Further scrutiny revealed the fact of its great size and distance, together with the discovery of four satellites. Six were conjectured by Sir William and others; but more recent observations have shown that there are but four, at all events *visible* to human sight even with the most powerful telescope.

The diameter of Uranus is, according to Mr. Proctor, 33,250 miles; according to Sir W. Herschel, 32,217; being four times that of the earth's diameter. Its volume is said to be seventy-four, by some eighty-two, times that of the earth; and its mass, $13\frac{1}{2}$ times greater than that of the earth; its specific gravity equals about that of ice; consequently exceeds in density considerably its larger brother Saturn.

The disc of the sun at Uranus would dwindle to a mere bright star like Venus, the enormous distance not presenting any apparent disc. The light and heat, therefore (if any), reaching these distant worlds, must be proportionately diminished to a *fraction*,—the *proportion* between the relative discs of the sun and planet being 390 to 1.

To speculate upon the habitability of Uranus would

be *useless*. No features are discernable on the disc, even with the most powerful telescope; and the inclination of its axis to the plane in which it moves can only be guessed by the revolutions of its satellites, on the assumption that they (as *is generally the case*) move in the plane of his equator. If this be the case, then the axis of this planet is nearly at right angles to the plane of its orbit,—a strange and wholly different arrangement from any of the other planets, and still more strange by the fact that the satellites are thus moving nearly vertically or at right angles to the plane of the orbit in which he moves; but are retrograde, appearing to move from east to west instead of from west to east, the latter being the invariable direction of all other satellites. That this would produce a climate wholly unsuitable to creatures in any way resembling ourselves, Mr. Proctor shows most fully; while, even if habitable, the strange condition of a year answering to eighty-four of our years, during twenty of which the little star called their sun would in many parts of this planet be out of sight altogether, places a complete barrier to any speculations as to its inhabitability.

As to Neptune, all that has been said of Uranus applies in a stronger degree,—the principal real interest attached to this planet being the extraordinary triumph of science in its discovery. Neptune is a little larger than his arctic companion, being 37,250 miles in diameter. His volume 105 times that of the earth, his seasons (if any) would be impossible to speculate upon in a year equal to 160 of our terrestrial years. The change and duration of climate he would undergo would be such as to separate him entirely from any analogy with the other

members of the system to which we belong ; and if there are inhabitants, whose ages are counted by his years, the lives of Methuselah and the antediluvian patriarchs dwindle into a comparative past of a few days.

The circumstances of the discovery of this planet by the undesigned coincidence of the observations of Mr. Adams and M. Le Verrier are so well known now, that for information upon this subject I must refer my readers to other works which treat *in detail* of this remarkable and most wonderful event ; to state which, generally and briefly, two astronomers, each without any communication with the other, were at the same time carrying on the same process of calculation for the same purpose : viz., to account for the disturbances observed by both from different parts of the world at the same time in the SAME PLANET URANUS ; to account for which disturbance or perturbation in his course, both astronomers entered upon a mathematical calculation of all the *attractive powers possible* to act upon the *planet*, and were both led *ultimately almost simultaneously* to the same conclusive result,—that the disturbance was caused by an exterior and as yet *invisible body*, and were at length both led to the *very spot in the heavens* where that body *should* be found, and *was found* : viz., to a *little telescopic star* in the *vast concave above* ; but really to a huge planet 37,000 miles in diameter, and above 900 millions of miles beyond Uranus, the subject of disturbance.

Such in brief are the facts of this discovery,—facts which, more than any other, go to prove not only the power of *man's intelligence* that is *able to calculate* and realize such a problem, but the Divine power, which at certain times and periods is put forth for special pur-

poses, and which inspires, as it were, at those periods, a *coincidence of mental effort* to effect *some great discovery*,—*designedly separating the discoverers* to prove that it is *not of men*, nor of chance, *but of God*, that such things are *done* ; that there is a *time* and a *purpose* for *everything under the heavens* ; and when a *truth* depending on one man *might* be questioned or despised or forgotten, a second witness at the same moment is raised up to *corroborate* the wondrous fact, and prove that the *inspiration* that led to the thought, and the *coincidence* that set two men working unconsciously together, *alike* proceeded from the SAME GREAT MIND that rules the Heavens,—the *Heavenly Creator*.

It might be thought that the discovery of Neptune was not after all of such importance to us as to warrant such an interpretation of this coincidence ; but setting apart the importance of the additional knowledge of the extent of our solar system we have thus gained, and the fact that *another world* is added to our catalogue of previous worlds, the very chain of *circumstances* which led to its discovery is sufficiently evident to *impress the mind of the most thoughtless materialist* that the universe consists of something more than atomic senseless matter and law ; and that there *is One* above our heads, who, while He is the Creator and Maker of all *matter*, is the Personal Controller and Ruler and Inspirer of all men's noblest thoughts, and indeed the Eliminator of all scientific knowledge and *discovery* that we have ever made ; and to teach men (as the prophet says was *God's object* in depriving the *haughty Chaldean King* of *his mind* for a time) to know that the Most High *ruleth* in the kingdom of men,—in the kingdom of *mind* as well as *matter*.

THE ASTEROIDS, OR MINOR PLANETS AND METEORS.

HALF-WAY between the orbits of Mars and Jupiter, lies a mysterious zone (*i.e.*, if it may be truly so called ; for its extent has not yet been arrived at, and it is quite as probable that this system of *planetary* bodies extends to the sun) of planets or planetary bodies of comparatively diminutive size, but probably of great number,—the number discovered to the present time (1874) being 120 ; but *suggesting* the presence of many more yet undiscovered. Their individual magnitude is so *trifling*, as almost to separate them in class from the planetary worlds on either side of and around them, and to lead us to classify them almost as large meteors or aerolites rather than worlds ; while whatever way we view them, their *great number*, their *recent discovery* (all but four being discovered since 1845), their peculiar position, and still more peculiar orbits, are so suggestive of interest and mystery, that though nothing can be said of their physical condition, from their distance and minuteness, or their use in the solar system, they form a subject of continued interest to astronomers,—an interest kept alive by the almost annual appearance of one or more of these miniature worlds, which have nearly exhausted the vocabulary of the heathen gods and goddesses, given to them and their predecessors,* by their *number*, as they have put to fault the various theories of astronomers to account for them. For myself, I prefer

* Why the names of these false deities should be given to the most beautiful and wonderful objects in creation, planets and stars, I do not see.

giving them a place *here*, with their smaller companions, meteors ; because it seems to me that they resemble them more than the larger and probably inhabited planets,—companions to the family to which they yet seem to belong, and bear the same relation to them as the half-grown child does to the parent,—while the meteors represent the infants.

But first let us remark upon this discovery. Twenty years ago but four were known to the inhabitants of the earth,—Juno, Vesta, Ceres, and Pallas,—diminutive objects only seen with the telescope ; and yet from the peculiarity of their orbits intersecting each other, combined with their position between Mars and Jupiter, where a whole planet was *suspected*, and it was calculated *should have been*, according to Bode's law, which was believed to govern the respective distances of the others. This rendered them four objects of interest and speculation to astronomers. And in the year 1851 it was actually announced, by the then President of the British Association, Sir David Brewster, that the speculation of Dr. Olbers, the eminent astronomer, that they *were four fragments* of a broken planet that once had revolved there was the fact ; that it was proved by the *remarkable intersection of their orbits with each other*, each crossing the orbit of the other ; together with the fact that a planet was *due*, so to speak, in the place where they were found ; that these fragmentary planets, when put together by calculation, had actually realized to the mind (or would make) one large planet of five thousand miles in diameter, and whose night and days were $51\frac{1}{2}$ hours, which once had revolved there, but which had met with a catastrophe, either by explosion from within or by collision from

without, which had split it into four fragments, and sent each as a separate planet *revolving in their present orbit*, which would necessarily be under such circumstances just what it was, causing each portion of the planet to return and pass through the point where the disruption took place, and thus intersect each other's orbit.

But let us give it in the very words of Sir David Brewster, himself one of the most *gifted* as he was one of the most illustrious ornaments of science. At the time when he announced it, 1851, seven more fragments or minor planets had been discovered.

"Within the bounds of our own system, and in the vicinity of our own earth, between the orbits of Mars and Jupiter, there is a wide space which, according to the law of planetary distances, ought to contain a planet. Kepler predicted that a planet would be found there; and, strange to say, the astronomers of our own times discovered at the beginning of the present century, four small planets, Ceres, Pallas, Juno, and Vesta, occupying the very place in our system where the anticipated planet ought to have been found. Ceres, the first of these, was discovered by Piazzi, at Palermo, in 1801; Pallas, the second of them, by Dr. Olbers, of Bremen, in 1802; Juno, the third, by Mr. Harding, in 1804; and Vesta, the fourth, by Dr. Olbers, in 1807. After the discovery of the third, Dr. Olbers suggested the idea that they were the fragments of a planet that had been burst in pieces; and considering that they must all have diverged from one point in the original orbit, and ought to return to the opposite point, he examined these parts of the heavens, and thus discovered the planet Vesta. But though this principle was in the possession of astronomers, nearly forty years elapsed before any other planetary fragment was discovered. At last, in 1845, Mr. Hencke, of Driessen, in Prussia, discovered the fragment called Astræa, and, in 1847, another, called Hebe. In the same year our countryman, Mr. Hind, discovered other two,

Iris and Flora. In 1848, Mr. Graham, an Irish astronomer, discovered a ninth fragment, called Metis. In 1849, Mr. Gasparis, of Naples, discovered another, which he calls Hygeia; and within the last two months, the same astronomer has discovered the eleventh fragment, to which he has given the name of Parthenope. If these eleven small planets are really the remains of a larger one, the size of the original planet must have been considerable. What its size was would seem to be a problem beyond the grasp of reason. But human genius has been permitted to triumph over greater difficulties. The planet Neptune was discovered before a ray of its light had entered the human eye; and by a law of the solar system just discovered, we can determine the original magnitude of the broken planet long after it has been shivered into fragments,—and we might have determined it even after a single fragment had proved its existence. This law we owe to Mr. Daniel Kirkwood, of Pottsville, an humble American, who, like the illustrious Kepler, struggled to find something new among the arithmetical relations of the planetary elements. Between every two adjacent planets there is a point where their attractions are equal. If we call the distance of this point from the sun the radius of a planet's sphere of attraction, then Mr. Kirkwood's law is, that in every planet the square of the length of its year, reckoned in days, varies as the cube of the radius of its sphere of attraction. This law has been verified by more than one American astronomer, and there can be no doubt, as one of them expresses it, that it is at least a physical fact in the mechanism of our system. This law requires the existence of a planet between Mars and Jupiter; and it follows from the law that the broken planet must have been a little larger than Mars, or about 5,000 miles in diameter, and that the length of its day must have been about $57\frac{1}{2}$ hours."

Now this *doctrine (not the planet itself)* has long since *exploded*, as also Mr. Kirkwood's law, on which it was partly founded, which had been proved a *fallacy*. Long before the *vast number now discovered* had been brought

to light, which in itself would have been sufficient to have destroyed this theory, the impatient curiosity of scientific astronomers had proved its fallacy. Mr. Adams in this, as in the case of Neptune, was ever the first in the field, and completely *overthrew* the theory. Let me add, Sir William Hamilton, the first mathematician the world ever saw, had at the personal request of the writer investigated the matter; and the result of his calculations, long before I was enabled to see those of Mr. Adams, was given to me: "No! No broken planet."

Scarcely was this announced, when a crowd of witnesses to the scientific denouement came crowding into the court of the heavens; declaring unanimously that they were *independent* or *minor planets*, and had never experienced a fracture from an original parent mass; and that they form, although small individually, a grand zone or ring of planetary glory,—far more wonderful than the former theory!

An examination of these minute bodies has revealed the fact, that though some few do intersect each other's orbits, the greater number do not. And yet so interwoven are their orbits one with another, in consequence of the varied inclinations of their orbits to the plane of the ecliptic,—in and out, up and down, at different angles,—that the French astronomer, D'Arrest, says (looking at them collectively, and supposing the orbits to be composed of *solid rings* of wire), "It would be impossible to lift one ring or orbit without lifting *the entire* in one tangled mass." The average size of these bodies being not more than from two to three hundred miles in diameter (not so large as the European Continent), precludes at their distance any observation of

their physical condition, except their *varying light*, which can be seen in many; and has given rise to conjectures as to their being *uneven bodies*, or having variable atmospheres; also the variety in their colour,—some being brilliant white, as Vesta, others dark red. It would be vain to speculate on these as inhabited worlds. That it is not impossible some of them may be inhabited, is true; but the condition of persons on such little planetary islands floating in the vast Pacific of space would be a strange one,—an inhabitant being enabled, if their power of locomotion were equal to our own, to traverse some of them in their entire circumference in a single day; while the power of gravity on them would be so light, that a spring of sixty feet might be given by a man* with muscular power equal to ours, with as much ease as he could jump a yard here. All this is but a useless speculation however. But now there are more interesting questions connected with them: (1) how came they where they *are*? and (2) *what are they*: i.e., to what class of heavenly bodies do they belong? With regard to the first question, it is in the opinion of the writer answered by the reply to the second: viz., they are but *large meteors*, and *meteors* are but *small planets*. And the reply to the question how they came where they are, will be reduced to the reply to how came the planets of our solar system *to where they are*? That reply has never been given in my mind satisfactorily by any theory of materialism ever propounded, beginning with the most plausible perhaps,—that of the greatest mathematician the world ever saw, La Place,—whose

* Sir J. Herschel on "Stars."

nebular hypothesis to account for the present arrangement of the solar system every one has heard of, if they have not read. Yet his theory, clear as it is, and in many respects the best yet propounded, breaks down in many points, and cannot be accepted fully: in truth it is vain for man to expect to discover the *secrets* of the Divine creation of worlds; and we must be content with *marking* and *recording* the *facts*, without idly speculating upon their *origin*. We may however fairly place these minor planets and meteors, whatever be their *origin* or distribution in space, as of the same class: viz., *solid material bodies*,—shining not by their own light, but by *reflected* light,—paying allegiance to and owning the prince of *our* centre, and alike performing their orbits correctly round *their* common centre.

In *our* case (*i.e.*, in the case of the solar system round our sun) I purposely class the *minor planets* with *meteors*, meaning thereby solid material masses of comparatively smaller size; because I find other writers (as Mr. Proctor) classifying meteors rather *with comets*, with which, in my opinion, they have *no connection*. Planets may vary from the size of Jupiter to that of a common pistol-ball, yet they are the same. It appears to me that comets and their attendant meteorites are a *different species*, though *the genus* may be the same: *i.e.*, all matter is the same,—composed of the same *materials* in different conditions.*

* It is well known that there is an *extensive atmosphere* of matter surrounding the sun, and that the sun is constantly *discharging* to *vast distances* in *space oceans of matter*,—so much so, that it is probable that from the orbit of Venus inwards to the Sun, presents a spectacle of thousands of *meteoric bodies* thrown off by our great luminary, and so enlightens that brilliant planet that she needs no moon. This action of the sun probably extends over the boundary of the solar system.

If we ask then, What are the minor *planets*, and how came they where they are? I would reply, They are planetary masses of matter, and have been placed where they are by the Creator. And if it is asked, What is their *probable origin*? I should say, *I know not for certain*: it may be however that they were originally *thrown off from the sun*; or as space is full of such matter, they may have been placed where they are *from without*, and brought within the sphere of the sun's attraction. The former, however, I think the most likely of the various human hypotheses; but nothing *certain* is known, *but* that a *zone* or mass of them, of unknown extent and number, *exists* between Mars and Jupiter, and probably millions through the solar system, performing all the functions of the other great planets.

As to the smaller *meteors* with which they are associated,—I believe them to be, though not visible, universally distributed,—not only through the solar system, but through *infinite space*; and that they are the same materials of *which all worlds are formed*:* that though probably there are innumerable systems of these bodies attached or thrown off the *stars and suns through the universe*, in rings and masses, from a larger body, such as the sun,—that they are universally diffused through space, and have *individually a precarious existence*, being, from their small size and varying inclination of their orbits, constantly attracted by the larger bodies, and dissipated by frequent collisions with them and their atmospheres, *millions of them doubtless* falling upon our

* The spectroscope has proved the *identity* of *all material bodies* as regards their components, the only difference being the different proportions in which they are mixed; and their condition, either as gaseous, fluid, or solid.

*earth and moon and other planets, as well as their parent suns, in the course of every moment. Why this should be, or their use in the universe it is not for us to attempt to say:** they are *there*; and are a constant evidence that infinite space is not empty space, but infinite extension of matter.†

The size of some of the larger meteors or boulders is considerable. The following is an interesting account of the descent of one in Canada, into Lake Ontario, in September, 1867:—

“DESCENT OF A METEOR ON A LAKE.

“Captain Turner, of the schooner *Algerine*, who arrived in Hamilton on Friday morning, reports having witnessed, at about eleven o'clock on Tuesday night, a splendid phenomenon in the descent of an immense meteor into Lake Ontario, which struck the water not more than 300 yards from his vessel. The captain was standing on the main hatch. The vessel was on the starboard tack, and sailing along finely, with a light south-west breeze, for Port Dalhousie, and about twelve miles off the Niagara Light-house, bearing S.S.W. Presently his attention was attracted by a sudden illumination from the north-west, which almost instantly increased to a dazzling

* Mr. Proctor suggests as a probable use for them, the gradual increase or *growth* of planetary worlds, by their constant accession and falling upon them. I do not think however this can be borne out by experience of our own globe, which shows neither increasing size, nor any appearance of such a vast quantity as would be required to swell her dimensions in the course of ages. The quantity of meteoric matter on our surface is very trifling.

† The meteors here referred to are sometimes termed *aerolites*, or *air stones*, sometimes *boulders*, in distinction from those lighter bodies that form the star-showers, to which the term *meteorite* has been given. Though doubtless having a common origin, and often mixed up with the large and heavy meteors, these latter as a mass generally seems to be composed chiefly of smaller and lighter particles, which (as iron filings fly to the magnet) seem to follow in the train of the great magnetic agents and powers of the universe, the comets, with which recent observation has associated them.

brilliancy. On turning he beheld a large body of fire in the heavens, which seemed to be approaching at a descent of about thirty degrees, and growing rapidly larger as it came nearer, the observation of time being so brief as hardly to admit of computation in seconds. The momentary impression of Captain Turner was that certain destruction awaited his vessel, as the terrific missile seemed to be directed to strike the vessel broadside. The time for reflection, however, was brief; and the light emitted was so blinding in its effects, that the man at the wheel and another of the crew on deck fell prostrate, and remained for some time completely stupefied with terror.

“The Captain himself, as he states, remained transfixed, and saw the fiery body enter the water some 300 yards ahead of his vessel, about two points to windward. A loud explosion attended the contact with the water, which was sharp and deafening, equal to a thunderbolt close at hand; and a large volume of steam and spray ascended into the air, which was noticed for some moments afterwards. The Captain estimates that the meteor was a body of some twenty feet in diameter. A long trail of flame of the most intense brilliancy was noticed as it struck the water. Captain Turner arrived at Port Dalhousie on Wednesday morning. He states that his nervous system did not recover from the shock experienced for many hours afterwards.”—*Quebec Gazette*.

THE MOON.

“Soon as the evening shades prevail,
The moon takes up the wondrous tale;
And nightly to the listening earth,
Repeats the story of her birth.”

ADDISON.

THE physical history of the moon, although our nearest neighbour in the heavens, and the object of our close and constant scrutiny, still remains a profound mystery to man; not as regards its design and use to us, which are sufficiently obvious, but its origin and past history.

When was our satellite born, and *how*? and to what cause are we to attribute her present rugged and forlorn condition? Are we to regard her as a deserted world (once inhabited), or as the rough cradle for a future world? We should certainly like to have been present, when, according to the poet, she related her own history to the earth, as given at the head of this chapter. Notwithstanding the acknowledged beauty and popularity of the poem from which this verse is taken, and the well-known celebrity of its author, I have always thought, when reading it (making all due allowance for poetic license), that the earth needed not to be told the Moon's story, as she must have known it before the Moon (as surely as the mother knows and could tell the story of her child's birth before the child); that, if it was as Addison describes, the earth must have been sadly tired at the recital of the same story every night, and would say with Hyppolita (if she could speak),—

"I am a weary of this moon: would he would change."—

Midsummer Night's Dream.

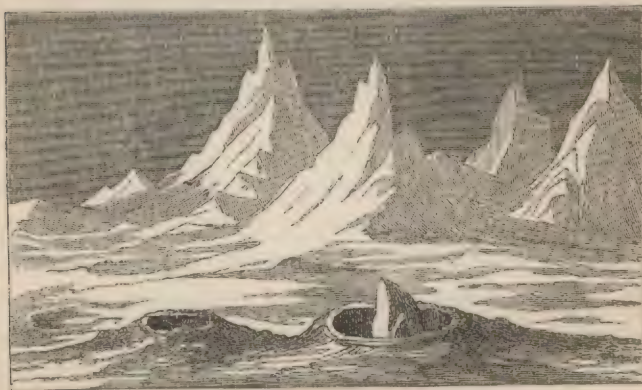
Indeed, *whenever* or *however* it happened, it might have been told in a very few words, as the writer hopes to attempt to do on this occasion, however imperfectly, having elsewhere described more fully the other particulars relating to the present condition and scenery of our beautiful satellite.* But to us (the inhabitants of the earth) the moon is still an enigma,—a sealed book,—as we did not enjoy the privilege of hearing her story. And notwithstanding the speculations and conjectures

* Vide "The Lunar world, her Scenery, Motions," etc., by the Rev. J. Crampton. A. and C. Blackie, Edinburgh. Fourth Edition.

of astronomers, we have not yet arrived (to demonstration) at the truth of her past history, or the probabilities of her future. Our mother earth has kept the secret so well that we know little or nothing about her, and dare not even draw an analogy from our own condition to her's. Consequently the lunar history remains now as a question for speculation, to any extent, from the soberest to the wildest theory.

The Moon, herself, is indeed (it must be allowed) the most provoking object in the heavens. She is a mixture of opposites, being at once the most *lovely*, and the most *desolate* and *dreadful*; the *softest* and the *mildest*, and yet the *hardest* and the *roughest*. The most soothing and attractive to the Poet, as she smiles from behind a cloud; and yet the most terrible and awful to the Astronomer, as he looks at her with a shudder, and, armed with a telescope, ascends her grand mountains and wanders over her dreary plains and solitudes, or looks down into her fathomless gulfs and abysses. She is the easiest to be seen (being the nearest) of all planetary bodies, and yet not near enough to satisfy us fully as to her condition. We know much less about her than we do of Mars, but with our eye at the most powerful telescope she still leaves us a bridge of mystery to be crossed, a gulf of ignorance to be filled up. We cannot get to the bottom of her real state. She is sufficiently like the earth, too (in her general contour), to induce us to make comparisons and draw unfounded similitudes and conclusions,—and sufficiently *unlike* the earth to make us draw equally unfounded *contrasts*. Chains of mountains extend over her surface, like our own; huge sandy-looking plains

(once called seas) stretch across it; seeming rills or rivers (more probably, in reality, fearful gulfs and fissures of unknown depth) wind their way through it; Lofty volcanoes of Alpine height, the shape and appearance of our own, rise from her surface by the hundred; and craters, or ring-shaped hollows, or pits of various and unknown depths and infinite variety of size, from half-a-mile to wall-surrounded plains of fifty or seventy miles across. These are sown broad-cast over her rough and shining bosom, exhibiting a scene of deso-



Lunar Apennines.

lation which has no parallel on earth. So numerous are these crateriform objects, indeed, that in some places, as Nasmyth says, in the instance of the smaller ones, the surface is literally frothed with them, and conveys the idea that our satellite once upon a time had "come to a boil," or effervescence. The ebullition theory suggested by Hooke being the only one that would seem to satisfy the fearful condition of that strangest and wildest of places.

No sign of water, or atmosphere either, is to be

detected. If any of either exist, they are too minute in quantity to be appreciable; at all events, not a cloud has ever dimmed it, nor a shower of rain ever blessed it. And though, as if purposely to deceive us, some of the lunar plains occasionally assume a faint *green*, to lead us to think *there* is grass or forest, it is all a deception of our wily satellite, as Shakespeare says,—

"The moon is an arrant thief;"

and if we could get a *little* nearer her than we *can* with our present telescopic power, we should doubtless ascertain the truth that there is nothing of the kind,* and that our satellite might be more fitly compared to one of the accursed dry places mentioned in Scripture, where evil spirits are said to walk, seeking rest and finding none. And yet in the face of all this, with every square foot of it measured to a nicety (*i.e.*, of the side next to us,—we are not responsible for the other side), with the height of every mountain recorded, the shape of every peak and precipice, and the winding of every bay drawn more accurately than the terrestrial features (as may be seen in Nasmyth's beautiful and wonderful book, recently published), with the boundaries of every great "mare," or sea (so called), as plainly mapped out as though a skilful lunarian engineer, employed by the lunar government, had been at work there,—with all this we know nothing about the lunar history, but that the Moon is a planetary body that seems to have been all but rent in pieces by forces the

* Were there vegetation there, the usual changes from green to brown (as on our earth) would be seen.

exact nature of which we cannot tell for certain, though we may conjecture that she is either the sad remnant of a former paradise,—a deserted habitation over which oceans once rolled, where forests were green, and flowers bloomed and vegetation flourished, where angels perchance walked and talked and smiled,—or, a mere cosmical desert, from the beginning only intended for two great purposes: first, to give light to us here; and secondly, to act as a balance or moving power to our ocean tides,—to be, as Shakespeare calls her, the “governess of our seas,” as well as the lovely companion to our nights, but possessing nothing in itself but its own barren rocks and plains and mountains and secret fires (*i.e.*, if they have not yet died out,—and if they have, representing but a lifeless barren rock in the heavens), having been so since her birth, and designed to be so always.

Such a view of our satellite, it must be acknowledged, leaves our minds (like her surface) a chaos, and makes us glad to retire to a distance from her terrors and sublimities, and to enjoy her peaceful light and luxuriate in the prospect of her picturesque beauties as seen on earth with the naked eye. We prefer to see her silvering the ruined windows of yonder ancient abbey,—as the poet suggests,—

“If thou would’st view fair Melrose aright
Go visit it by the pale moonlight,
When the broken arches are black in night
And each shafted oriel glimmers white;
When the cold light’s uncertain shower
Streams on the ruined bastion tower.”—

SCOTT.

We love to see her travelling along the sharp outline of



MOONLIGHT SCENE.

LOUGH BEAY, CO. WICKLOW

4. CRAFTON, DEL.

that dark mountain, or shining into its peaceful vale below. We like to see it bleaching the sails of that large vessel far out at sea, lying still as she does upon a calm flood of silver,—or shining down through the open of the trees upon that green forest glade,—or breaking forth suddenly from behind that dark cloud to light up the waters of the deep lake below. We love to see the clouds hurrying past and chasing each other over her calm and brilliant face, while she seems to plough herself through their midst, insensible to their haste and fury: like a good ship on a stormy sea (a sea of clouds for her),—now she disappears, but to emerge again in another moment as bright and beautiful as ever. But it is time to stop all this,—its being written at all being only a strong proof what power the *distant* Moon has to stir the memory and imagination, and awaken the poetry of our nature to its depths (if we have any); and that the poet or the artist will find an inexhaustible fountain of delight in the simple contemplation of our beauteous satellite. But still the inquisitive mind will keep asking, What about her origin? How came she to be *where* she is, and what she is? In reply to this, we may speculate to our hearts' content; and whether we prefer to follow a Herschel, a La Place, a Tyndale, or any other speculator in nature, for a little way, it will be found that there is a point where we *must* all stop, and say, We know nothing more about her: but this *for certain*,—it will be found in Genesis i. 16,—it is a short history: "And God made two great lights; the greater light to rule the day and the lesser light to rule the night." It must come to this after all. It is very well, and very interesting, to speculate on such subjects:

"The works of the Lord are great, *sought out* by all those who take pleasure therein." It is, therefore, perfectly legitimate to theorize upon the material world, if we like to do so; but the *when* and the *how* of all created objects around us,—*i.e.*, the time of their origin and mode or manner of their creation,—generally appear to us as inscrutable mysteries as their *future*. But even upon these it is legitimate to theorize, provided we give to the Creator the glory due to their creation, by whatsoever means we think it may have been brought about. Secondarily speculating then, in this manner, upon our satellite's origin and present condition,—not presumptuously, but *reverently* and *reasonably*, though not *infallibly*,—I think it may fairly be conjectured, that *whenever* or *however* the Moon was created, she is the child of the earth, as the earth is the child of the Sun. Many things conspire to induce a belief in this; and the theory attributed generally to La Place* (though that celebrated mathematician was not the first to suggest it) when somewhat modified, presents perhaps as fair a conjecture of the mode of the Moon's creation as could be made,—the same principle applying to the history of the earth as well as her satellite: *viz.*, as the earth was a morsel sprung from the sun, so the moon is a morsel of the *earth*, cast off her parent when that parent was in a state of fluidity, and of vastly greater magnitude than she is now,—flung off as the half-fluid mud or water is flung from the tire of a wheel. The beginning of the Moon's existence, in fact (it may be concluded), was a case (speaking of secondary causes) of what is called *evolu-*

* "Système du Monde."

tion or development: *i.e.*, the Moon came forth from the earth, not as in a moment formed by the Creator's hand (as man is described to be), but slowly and gradually, taking probably countless ages for its completion, and accomplished by what would be called by Materialists a mere material process; but really and behind all, we maintain, by the almighty power of God and the laws which He impressed upon the *matter* and the movements of the orbs He creates and is continually creating.

To the creation of Adam, indeed, such a term as *evolution* could not properly apply, and would be wholly unwarranted from the description given of his creation in Genesis, where it is distinctly said, on the last day "God formed man of the dust of the earth, and breathed into his nostrils the breath of life, and man became a living soul" (*i.e.*, *then* and *there*);* but there is no such description of the earth or Moon's creation; and to all the heavenly bodies the term *evolution*, or development, as relating to *their* creation, is perfectly legitimate and consistent with the Creator's sovereignty and power, while from what we see and know of these heavenly bodies it is the most probable theory, the power and skill and design of the Almighty being quite as perceptible in creation by *evolution* (or that slow and gradual process by which the worlds are first formed from nebulous and then fluid or molten matter, till they

* Now either the story in Genesis must be a fable, or the doctrine of evolution, as regards the human race, must be given up; and not only Genesis, but geology, as well as anatomy, physiology, and we may add, and psychology, furnish ample proofs of the improbability of the Darwinian hypothesis of development as regards the creation of man.

become in process of ages solid bodies suited for habitation), as it is exhibited in the quicker and more immediate, or if you will, exceptional creation of man or animals; there is something quite as grand, indeed, if not more sublime, in these slower processes of creating worlds which require ages for their completion, but which are ever before the mind of God, and are accomplishing His plans and effecting His design and intentions under the continued impress of *His* power to whom time is as nothing, any more than the *extent*, or *number*, or *magnitude*, of the things created. It is true that we cannot form a conception of the *manner* or *mode* of Adam's immediate creation any further than it has been revealed to us; but the difficulty of conceiving this is not greater, but much less than that of man created by evolution and transmutation, and natural selection according to the Darwinian hypothesis.

I think then that it has been fairly and reasonably *conjectured*, by the best astronomers and physicists, that the Moon was the offspring of *her* parent earth, as well as the *other* satellites of *their* central globes, such as those of Jupiter and Saturn. Those who wish for the details of this wonderful process of planet-making must consult La Place's celebrated work, "*Système du Monde*," or those modifications of it which subsequent writers have made upon it, in which the whole process may be followed, from nebulous matter or fire-mist to the fluid or molten globe of metal, revolving when in a soft or semi-fluid state so rapidly that its poles are flattened and its equator bulged out (as demonstrated by Sir Isaac Newton to have been the case with our own globe); and as it cooled down by radiation into

space and the exhaustion of its fires, and contracted,—reducing its dimensions and leaving behind it, or throwing off from it successive rings of its own matter, such as are seen in the planet Saturn, which alternately become consolidated into globes like the parent planet, and become attendants, such as our Moon is upon us or as Jupiter's moons are upon him; the different distances at which his satellites are placed corresponding to the different rings of matter, and the extent and original magnitude of the parent planet; the place of the outermost satellite representing the original extent or outermost ring.

This theory is so wonderful, that it may be hard for us to realize this process to our imagination, yet there is every reason to believe it is the most rational conjecture which can be formed of the *mode* which the Almighty and All-wise has adopted for the accomplishment of His purpose in the formation of worlds. Millions upon millions of ages are probably required for the formation of a single planet, and millions more for its satellite; the formation * of the satellite being in all cases necessarily subsequent to that of the *planet* (hence our Moon cannot be as old as the earth) as regards its birth or origin. But with God we must remember time is of no account, and the Creator's work of stocking the universe in this way, from the first beginning to the end, never ceases, and is ever new. New worlds are for ever beginning their misty birth;

* This must be understood of the *commencement only* of the satellite's existence; as being necessarily much smaller than its primary, it will probably cool down much more rapidly, and arrive at its final condition considerably sooner.

half-completed worlds are in their childhood ; while completed worlds have entered upon their manhood, or an *old age* that knows no end, or never grows old, except in advancing to greater perfection,—a perfection not only of material solidity or beauty, but of animal life and intellectual greatness of which such worlds are the seat. When we bring before us the thought of an *infinite number* of such worlds, their growing into existence or perfection, we can readily understand that space can never be vacant, or want inhabitants; for the universe, as it will be ever growing, will be ever furnished with worlds and their populations.

But a few questions still remain for the curious to be solved respecting the Moon. Has she passed through any phase of life, animal or vegetable? Is she a *ruin* of a former fair world, or a *building* never intended to be perfected? Different opinions exist upon this subject. For myself, I humbly venture to think that a *ruined planet*, or a planet become a ruin, unless temporarily, is an anomaly,—a thing which is to me the most *improbable*, and which we ought not *naturally* to *expect* in creation, which seems always advancing forward to *perfection*, and never *retrogrades*. Exceptional cases, it is true, may exist, but even in the case of the earth, which we are told is to be at least partially destroyed by fire, this is plainly *exceptional* and temporary,—possibly penal,—the consequence of sin, as Noah's flood was. Nevertheless there have been intermediate periods on the earth previously, and doubtless also on other planets, as geology testifies, where great changes and cataclysms of fire and water have taken place previous to a new state of things, as seen in our geological series: but after all

it is only to make way for a *better condition*. In this light, indeed, I think we may view our own final cataclysm by *fire*, as descibed by St. Peter, who adds, that it is only a preparation for a "new heaven and a new earth." Were we however to see any planet immediately after such a cataclysm, and before the new order of things had been established, we might reason as some now do in respect of the Moon, and say, this is the intermediate condition between the old and the new: this is a *ruined state* following a former flourishing state,—but only a preparation for a better: be it so! Now what of our satellite in respect of this supposition? It is a problem I fear that never will be solved by man, in this world at least; but speaking for myself, after an experience of many years' examination of our satellite, I am inclined to reject the hypothesis of the Moon's former habitable condition, notwithstanding some appearances on her surface that might induce one to believe in it. There are many more difficulties in accepting such a supposition than in rejecting it, notwithstanding the apparent resemblance in many points to our world, which leads many,—as it once did myself, on my first examination of her surface,—to believe that water once rolled over her plains, and vegetation clothed her surface, and an atmosphere surrounded her, similar to our own. Whether this ever will be the case, indeed, and that our satellite is the cradle of a future world of life,—is a difficult question, and one on which it would be impossible as useless to speculate, but which I cannot but look upon as improbable, and it may be remarked, even in reference to this, if the Moon is to remain as a satellite to the earth (and there is no reason to believe

that she will not), such a change in her condition would render her very unsuitable for a satellite. The possession of an atmosphere, in itself alone, would be a serious objection and obstacle to her discharging her present functions, while the necessary co-existence of oceans on her surface would still more embarrass the condition appertaining to our *present* clear and mild attendant, who though she is now the mistress and controller of *our tides*, would under these circumstances find herself in the opposite position, and *her* oceans and tides become the servants of the earth's powerful attraction, rolling her seas over her land and causing fearful lunar inundations. But setting aside her future condition altogether, I think an attentive study of the lunar surface will powerfully suggest the great improbability of her ever having been a past paradise or inhabited world, now wrecked and torn by her own fires; but, on the contrary, that she never was any better than she now is,—viz., a mere cosmical rock; but was once much worse,—viz., a molten, bubbling mass, containing gases and metals and other elements of violent combustion, such as are in the sun, but which having cooled down and contracted, left her present surface as it is,—like a once boiling seething pot of pitch that had hardened. And if water was once a portion of the mass of the Moon, which it probably was (oxygen being one of the invariable elements in planetary bodies), even if it remained during the terrible period of her history revealed in her present appearance, and oceans existed after her solidification, they would not remain long there, but would disappear rapidly, by evaporation from her heat, into space, or be swallowed up in the cavernous

body of the Moon,* where probably they are now, through the clefts and opens produced in her surface by rapid contraction, accompanying her *cooling* from the radiation of her heat into space. Along with the water, the atmosphere, if she had one (which probably she had) would disappear likewise, being dispersed into space, or solidified on her surface; while in the mean time continued explosions and throes of steam and gases, proceeding from within her fiery bosom, would upheave mountain chains such as we see, or form those strange circular pits called lunar craters, with the central mountain so conspicuous in them; or when the power from within was not sufficiently great, or the crust was too strong, forming but a convex surface, which many of them possess.

Thus the period when our Moon had water and atmosphere (if ever she had them) was a period when she could not have been inhabited, nor fit to perform the functions of a satellite to the earth, though doubtless designed to be so (as she now is) in process of time. But on looking at the peculiar conformation of lunar craters, being all nearly circular, together with their countless number and almost infinite variety of size,—from the mere bubbles, that seem innumerable, to the craters or wall-surrounded plains of fifty or seventy miles diameter,—we see something so different from anything on the earth that we cannot reason analogously to her former condition, nor her present resemblance to

* It has been calculated that the cavernous space in the centre of the Moon to the inner crust is about 500 miles in diameter. Such a space would contain amply any oceans or water that might have once existed on her surface.

us. Her volcanic period (if it can be termed such) whenever it took place, has been a cosmical and all but simultaneous outburst universally over the lunar surface, and not, as it is or has been with us, a partial and *gradual* and *successive* process, and still going on, attacking different parts of our globe at different times, which geology shows has been the case in *our* former cosmical history. There seems to have been *little* of successive *periods* of cosmical or volcanic action in the Moon; but cooling rapidly, from her smaller mass, it is probable that what we see now was effected *all but at once*,—i.e., by one great cooling and contracting, χ ages ago; which has not been succeeded by any other, nor left a single *fire alight* at present in the great lunar forge of nature. Hence we need look for no volcanic action in the Moon now,—that action has *long ceased*; its works are silent *there*, and its wheels are *cold*; and no geological strata would probably be found there to testify to a former state of life, for there was but one period in her whole history,—the period of her *solidification* and *contraction*; which has left her what she now is,—*waterless*, *airless*, and *lifeless*.

But recently the former idea suggested by Sir W. Herschel, and rejected in the instance adduced by him, that there were still active volcanoes visible in the Moon, has been renewed, and changes have been suspected on some parts of her surface by watchful observers of the present day, as well as by those of the last century. That slight *changes* in certain parts of the Moon may have actually taken place is quite *possible*; but even the best attested are far from conclusive, while in none of them does there appear to be the least

symptom of their being caused by *volcanic action*. The number of precipices in such a mountainous country might naturally suggest, as Mr. Nasmyth has said, *land-slips*, which though not likely to be frequent in a land where there is neither water nor atmosphere to disturb it, yet, as has been justly observed, the violent extremes of solar heat and cold to which the Moon is exposed every fortnight, must naturally produce the cracking or opening in her soil in some places, and in others, disturbance of the general equilibrium of her substance. But among all the *changes* supposed, none such as would be caused by *this* would seem to be confirmed, while the probability is that the objects in the Moon, seen under different angles of light and at different periods of the Moon's lunation, cause such changes of appearance as have led to these surmises. Such seems to have been the case with those instances enumerated by Mr. Webb (a close and skilful observer), also Schroeter of old, and not so much to be depended on; but more importance has been attached within the last three years to the changes noticed on a crater termed Linné, which, according to *Schmidt*, *Birt*, *Secchi*, and *others*, appeared to have undergone considerable *change* from what it was, as mapped by Schroeter, and Beer, and Mædler, and others. As Schmidt, of Athens, is justly celebrated as an accurate observer, his remarks upon this subject are considered of much weight, and for some time a close scrutiny was directed to this spot,—which I have frequently examined myself,—but the result has not been satisfactory as confirming the supposition of change, though some doubt still rests upon the subject. From Schmidt's observations, Linné is a

small crater compared to some, yet still of a considerable size, being about five miles across, situate in the Mare Serenitatis, or sea of calm. It will be found in Webb's map, in the department H., No. 74. This map has been reduced from the celebrated map by Beer and Mædler. This crater is represented in Ricciole's map, published in 1658. In 1788, Schröeter recorded the appearance of a *dark spot*, instead of a crater, where Linné had been previously seen by him. In 1823, Lohrman describes it as one of the brightest spots in the Moon, and exhibits it in his map as a distinct crater of about a German mile (five statute miles) in diameter, very deep, with surrounding wall and shadow, and visible in every illumination. In Beer and Mædler's celebrated map it again appears as a bright and deep crater. In photographs by De la Rue and Rutherford it appears simply as a *bright spot*. Thus for half a century, notwithstanding Schröeter's statement of 1788, it had remained distinctly visible; and, as is the case generally with all lunar craters, when the Sun was high it appeared as a bright spot, but when near the terminator or line of darkness and light, the crater became distinctly visible, with its circular rampart of walls and shadow both within and without.

In October, 1866, however, Schmidt in directing the telescope to it could find no trace of it: it had disappeared altogether. And where it should have been, near the terminator, no shadow could be seen as usual, either within or without the crater. Repeating his observation in November, Schmidt was equally unsuccessful. Linné had disappeared. Schmidt's character as an accurate observer and eminent astronomer put the matter apparently beyond all question as a fact, and

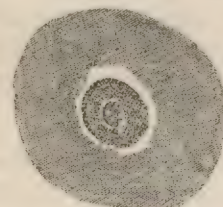
excited the attention of all astronomers; powerfully suggesting,—when coupled with Schröeter's observation of 1788,—a change taking place, and the existence of volcanic action still in the Moon. Mr. Proctor, however, mentions a curious circumstance in connection with this matter. That at the very time when Schmidt was looking in vain for the crater, Mr. Buckingham, of Walworth, took photographs of this portion of the Moon in which Linné was discernible; but only as a bright spot, and not more than one third of the brilliancy observed in two photographs of the same object taken by De la Rue and Rutherford in 1858 and 1865.

It may, perhaps, be suggested, as accounting for the difference of brilliancy, that it was owing to the manipulation of the photographs, and more probably to the state of the atmosphere at the time. But the fact remains still, that the two sets of photographs exhibited Linné as a white spot, and the last set of photographs also at the very time that Schmidt was unable to discover a trace of it.

Mr. Webb looked for it in December 1866, for confirmation or disproof of Schmidt's views, and describes the place where Linné should be as an "ill-defined whiteish mass on the floor of the Mare Serenitatis." This last exactly accords with my own observation of the same spot. Nor could I detect, either with my three-inch acromatic, nor silver-glass Browning reflector, the slightest token of a *crater*,—properly so called,—but simply a diffused white mass on the surface. Many astronomers concurred in Schmidt's views,—among them Father Secchi, whose observations are valuable, not only from a personal point of view, but from the superior clearness of the sky in Italy. He

watched Linné entering the Sun's light; and in place of the large crater exhibited in lunar maps, could only just detect, with the most powerful telescope, a *very small crater*, smaller than the craters which from their numbers have received no names. He adds, "there is no doubt that a change has occurred." Schmidt, it may be mentioned, afterwards detected this small crater. The explanation of the apparent change assigned, was that volcanic matter erupted from the bottom of the crater partially filled it, reducing its size to the small one detected by Secchi and Schmidt, and overflowing the ring-wall surrounding it, and pouring down the sides extinguished the shadows formerly seen both *within* and *without*, leaving nothing apparently but a sloping white patch or spot surrounding the minute crater, or portions unfilled. This theory, however (though plausible), has not been confirmed by subsequent observers, and the changes observed have been imputed by the majority, with greater probability, to optical deception, caused by the angle at which solar light was shed upon this crater. There are still, however, difficulties not explained fully by this theory, and some eminent observers, such as Mr. Birt, Secchi, and Schmidt, are still of opinion that a change has occurred. In reference to the *opposite view*, I here insert the explanation given by Mr. Burton, who was one of those who accompanied the expedition to the island of Rodriguez to observe the transit of Venus; also the tabulated record of the different observations made upon this celebrated lunar crater by eminent astronomers, kindly furnished to me by Mr. Burton himself, together with a sketch of Linné as it appeared to him. He says:—

"My strong impression is that there has been *no change* in the white spot of late, and that the discrepancies of observations of its dimensions by different observers have been occasioned by the selection of different points for measurement. Dr. Huggins has evidently measured the extreme diameter of the nebulous outer part of the spot, while others, including myself, have selected the more sharply defined inner portion to work upon, and have ascribed to it a diameter of about five seconds. The faint outer halo is not always equally visible, but when seen and measured it appears always about eight seconds in length, according to Messrs. Huggins, Tacchini, and Gledhill. My own latest results for the diameter of the whole brightness indicated a diameter of 7".75 on the 29th ultimo, on which occasion the composite character of the spot was well seen. The instrument used was the Woolwich seven-inch Grubb Equatorial, armed with a power of 200.



* Fig. 1.



Fig. 2.

"Thrown into a tabular form the results would appear as follows:—

Observer.	Diameter.	Date.
Huggins	7". 85	1867.5
Tacchini	7. 95	1867
Gledhill	8.	1868
Erck	4. 0	1873.5
Burton	5. 2	1874
Birt	4½	1873.6
Neison	4.	1874
Huggins	7. 5	1873.9
Burton	7. 7	1874.4."

* Fig. 1 is taken from a sketch made on June 4th, 1873. Fig. 2, from one made on Jan. 24th, 1874, in both cases with the 12in. reflector.

"Some observers have recorded the appearance of Linné at lunar sunrise, as that of a minute peak isolated on the ground of the Mare, and casting a conical shadow of considerable relative length. On the occasions referred to, other observers, with more powerful means, have seen the object in question as a minute and perfect crater. It has seemed to me that an observation made on January 24th, 1874, suggests an explanation of the discordance between the above quoted simultaneous observations.

"On January 24th, the definition being very good, I observed the craterlet, as a peak, casting an elongated conical shadow. The instrument in use was an eight-inch reflector and the power 220. I immediately opened the twelve-inch reflector, and with a power of 400 saw the craterlet as depicted in the sketch; the crest of the eastern wall being visible with this instrument and power, as a very slender line of light, which had escaped detection with the smaller telescope. The apparently continuous conical shadow seen with the eight-inch was therefore composed of two distinct portions: that thrown within the craterlet by its W. wall, and that cast externally by the E. wall."

Thus the matter of change occurring in this crater rests for the present, and I fear is not likely to be decided, unless telescopic power is vastly increased, which is most improbable. Nevertheless, increased watchfulness on the part of observers may result in the discovery of changes occurring in that strange and silent globe from other causes than volcanic action, which I cannot but believe is long since dead. With what we *do* know however of our satellite, I think the idea of her being inhabited may be dismissed *summarily*: *i.e.*, her inhabitation by intelligent beings, or an animal creation such as exist here. There is no sign of life or movement in that awful country, and we must perforce return to the great design of its Creator,—that it is merely intended

to be a satellite to the earth, so long as the Sun and Moon and earth thus exist. Whether all satellites are in a similar condition it would be impossible to decide; the distance of their nearest to us (Jupiter's) being too great to enable us to pronounce anything certain. Though it has been said by Mr. Proctor, and others, that they do not appear to be in the same condition as regards their rotation, and, unlike our Moon, show symptoms of a more rapid and complete rotation on their axis,* proved by their varying light and change of spots on their surface, and appearing sometimes as *black* spots, at transits across Jupiter's disc, and at other times as *bright* ones; from which Mr. Proctor argues, that they are unlike our Moon, and are probably seats of life and intelligence, while their primary, Jupiter, is a minor sun from which they derive their light. This *may* be the case, but at such a vast distance as they are situated it would not be easy to determine anything certain respecting their condition. Nor amidst the infinite and wonderful variety conspicuous in the heavens as in all nature, and the continual changes occurring there, would it be safe (viewing them analogically from our own Moon) to classify all satellites as in the same condition. In whatever way, however, we regard the Moon, whether in reference to her beauty or utility, we must be blind not to see the benevolent design which has given her to us as a satellite, whose soft and mild lustre rules and cheers the night, and whose power governs every wave

* The revolution and rotation of the Moon on her axis nearly coincide; the effect of which is to cause her to present invariably the same face to the earth.

that breaks upon our shores; and whose coming, appearance, and temporary departure from us, marks familiarly and pleasantly the division of the weeks and months and years of our own lives' history. These, at all events, may justly be considered practically as "the precious things put forth by the Moon," which we have every reason for believing will continue "so long as the Sun and the Moon herself endureth."



CHAPTER VI.

ASSOCIATION OF COMETS AND STAR SHOWERS.

"And behold a great red dragon . . . and his tail drew the third part of the stars of heaven."—REV. xii. 3.

COMETS may truly be considered as the enigma of the heavens. Suns and planets have yielded their many wonders, in some degree, to the insatiable curiosity and intelligence of the little restless being who, stationed on his grain of sand called earth, has surveyed and scrutinized them for thousands of years. Misty nebulae, and flying meteors, and distant firmaments have surrendered at discretion and laid open their wonders and real nature, and laid down their arms before the eye and intelligence of man armed with his telescopic tube or spectroscopic weapon; all have more or less been conquered, but comets—these flaming swords of heaven, these mysterious startling apparitions,—still defy research, and, though they spread themselves ostentatiously across the whole hemisphere as though to invite deliberate attention and investigation, they still continue to evade scrutiny, now aweing the ignorant or superstitious, now challenging and puzzling the scientific world. Though every motion has been observed and ascertained, their orbits calculated, their inner movements watched by thousands of curious eyes

and telescopes, all as yet is in vain. There shines the mysterious head with its dull vaporous light and brilliant nucleus within; there spreads the wondrous tail, now fanned, now forked, now multiplied into many tails, and spread over millions and millions of miles of the heavens. But what is actually known about comets? What is their nature and what their purpose and use in creation? To what class of bodies can they be referred?

No reply that can be depended on has as yet been given to any of these questions, and comets are still one of the mysteries of creation which remains yet to be unfolded. Many ingenious solutions of it have been suggested of more or less weight; but after all they are but guess work, and most of them as improbable as they are unproved.

Yet, in these days, at least within the last five years, it has been thought a recent light has been thrown upon their nature, which may possibly lead to the resolution of at least a portion of the mystery in which they are enveloped. The recent discovery of the remarkable and exact coincidence of the orbits of two comets,—that of 1862, called Tempel's, and 1866, with the orbits of the two principal systems of meteors, forming the splendid meteoric showers of August and November, 1866,—has led astronomers to the natural conclusion of the association of these systems in some way with comets, but in what way has not yet been proved. There are many other meteoric systems that have been associated with known comets; but those of the August and November meteors are the only periods that have been actually determined to be identical with the orbits of the two comets in question. This discovery, first noted by

Schiaparelli, seemed at first to give some possible clue to the nature of these strange bodies, and when ascertained startled the scientific world of astronomers not a little.

An association of *some kind* of these great systems with the comets could no longer be doubted, and expectation was consequently raised that we had at last got the key to the mystery of the being of these strange visitants, and a shower of meteors was in fact but the encounter of the earth with some portion of the comet, or something attached to it and inseparable from it—possibly a portion of its tail constituting the innumerable meteorites that flashed upon us in 1866, and into the midst of which the earth plunged, and through which she passed on that memorable night. If so, comets would be but the condensed material of which the meteors are composed, leaving their tail or wake of star showers or cometary matter behind them as they rushed on their orbit.

Thus we seemed to be on the eve of a great discovery, and for aught I know we may be still; but as yet, at least, it has not advanced a single step further, and no such conclusion has been adopted positively or universally by the astronomical world of science—nor can it be proved; and though a most remarkable association between the star showers in question and the two comets referred to has been shown and acknowledged, the actual nature of the association has not been ascertained, and the mystery of the physical condition of these bodies and their use in the universe is as great as ever; indeed, remarkable as the association is, there is nothing in the appearance of a comet to warrant its

relation to the meteoric showers in any way, except in the identity of its orbit with those systems. On the contrary, examination with the telescope reveals the very opposite, and nothing that would lead to such a conclusion. Any one who has ever seen a comet with the naked eye, or with a telescope (even the most powerful), would at once and at first sight reject the idea of its substance being composed of meteorites, or the cometary matter we then behold being in any way connected with or having a resemblance to the star showers with which we are familiar, and the composition of which we are well acquainted with; in fact, there is no resemblance whatever between a star shower and a comet, from its head to its tail (*i.e.* if it has such an appendage, which all have not), such, for instance, as Enke's short-period comet, or Biela's, of which we shall afterwards speak in reference to this theory,—though here, by the way, it may be questioned whether such a body should properly be classed at all with the large-tailed monsters to which we are accustomed to give that name. A nearly circular or elliptic nebulous and misty mass, with a faint bluish light, and an equally faint nucleus in it, hardly conveys the idea of its belonging to the class of such grand objects as that called Donati's comet of 1858, or other long-period and long-tailed comets, such as that of 1811 or 1843, the tail of which latter extended two hundred millions of miles, with many others that could be mentioned, such as Halley's; but not one of these convey the idea to the mind of their consisting of numberless discrete or separate bodies, or shreds of matter, such as constitute the meteoric showers. The most powerful telescopes directed to them have failed to

resolve any portion of them into separate stars, or meteorites, as can be effected even in those distant nebulae, which though to the naked eye, or a low power of a telescope, seem as misty as any comet, yet resolve into firmaments of separate stars under a high power telescope; in fact, the idea formed in the mind of the best astronomers of the ordinary and, what may be termed, legitimate comet, is a gaseous-looking body, containing a bright nucleus, more or less condensed, but the entire so transparent that stars can be seen through any part of it, while both nucleus and tail are subject to the most sudden and violent changes of size, shape, and direction, wholly inconsistent with the idea of their identity with star showers. Such phenomena were witnessed in Halley's comet, among many others, in the year 1835,—a comet, one of the most remarkable of all, as verifying the calculations of Halley as to the elements of its orbit, and fulfilling accurately his prediction of its returning after an absence of seventy-five years.

The close and searching examination to which this comet was subject seems to put out of the question almost its association with star showers, or any relation whatever to them, but seems rather to indicate some powerful magnetic or electric force, specially manifested on its approach and departure from the sun. At these periods it was carefully observed and noted, and drawings were made of it in all its different phases by some of the most eminent astronomers of the time, among which were Struve, Bessel, Schwabe, Sir John Herschel, and Maclear. Some of the remarkable phenomena then displayed we may here mention.

At its first appearance in October, 1835, when the present writer saw it with the deepest interest, it appeared to have no tail, and seemed but a small round nebula. The tail, however, very soon began to be formed, and, increasing rapidly, on the 20th of October attained its greatest length, which was 20 degrees; after which it decreased as rapidly, and by the 29th of October had diminished to $2\frac{1}{2}$ degrees. The circumstances accompanying this increase and decrease were remarkable, and such as in the opinion of the writer would seem to be opposed altogether to such an association of meteorites, or star showers, with comets as would imply that they were actually composed of the materials or tails of these objects.

On the second of October the formation of the tail took place by a violent ejection of nebulous matter from that part of the comet that was presented toward the sun. This ejection, however, was neither uniform nor continuous, but, like the fiery matter from a volcano, it was thrown out at intervals. After this no ejection was observed till the 8th, when it recommenced more violently than before, and assumed a new form. A second tail appeared and presented a direction opposed to that of the original tail, and therefore away from the sun. This was regarded by Bessel merely as the renewed ejection of nebulous matter, which was afterwards turned back from the sun as smoke would be by a current of air blowing from the sun in the direction of the original tail. From the 8th to the 22nd, the form, position, and brightness of the nebulous emanation underwent various irregular changes: the last alternately increasing and decreasing; at one time *two*, at another

three nebulous emanations were seen to issue in different directions, something in a swallow-tailed form, like the flame from a fan gas-burner. Sometimes the entire tail oscillated violently from one side to the other of the line from the sun through the head of the comet, as a compass needle oscillates between one and the other side of the magnetic meridian. So rapid was the oscillation that the direction of jets was visibly changed from hour to hour, the brightness of the matter being most intense at the point where it was ejected from the nucleus, and faded away as it expanded into the coma, curving backwards in the direction of the principal tail like steam or smoke before the wind.

On the 12th the comet appeared in uncommon splendour. The nucleus and flame, however, being alone visible, its appearance was most beautiful, resembling a jet streaming out from the nucleus like a flame from a blowpipe, or the flame from a discharge from a mortar, attended with the white smoke driven before the wind.*

Through all these wonderful transformations the stars were distinctly seen through it without diminution of their splendour, even through the very centre of the nucleus, as was the case with Donati's comet, through which Arcturus shone with undiminished lustre. Drawings by Messrs. Maclear and Smith of the strange phases of Halley's comet illustrate this fact most beautifully.

Sir John Herschel's deductions from these phenomena as seen by him at the Cape are as follows:—

* Lardner's "Hand-book of Art."

1. That the matter of the comet vaporised by the sun's heat escaped in jets, throwing the comet into irregular motion by its reaction, and thus changing its own direction of ejection.

2. That this ejection takes place principally in the part presented to the sun.

3. That thus ejected it encounters a resistance from some unknown force; probably an ethereal medium by which it is repulsed in an opposite direction, and so forms a tail.

4. That this force acts unequally on the cometary matter, which is *not all vaporised*, but a considerable portion is retained to form a nucleus.

Putting all these facts together which have been collected by the very first astronomers and observers of the age, and accepting Halley's comet as a sample of all others—for there is no reason to believe there is any difference in their materials—the question of the nature of the association of showers of meteorites with comets must be very doubtful; and the idea suggested by many, that on the night of the 13th of November, 1866, we were actually plunged into the depths of a *portion* of a comet is more than problematical. The changes of form and shape, and violent emission of matter, the contraction and expansion of the nucleus in approaching or leaving the sun, the entire loss and subsequent recovery of their tails, and the twisting and turning of those strange appendages in every direction, or the formation of several tails simultaneously, together with the cloudy and clearly gaseous transparent appearance of the entire body from head to tail, with the bright

darting scintillations, proceeding from the nucleus,* leave the impression of electric phenomena, and the explosion of an electric battery, rather than showers of material bodies, whose substance we are well acquainted with through the spectroscope, and which, though most of them it is true are very light yet are accompanied by others of the very same material, large and solid, many of which doubtless struck the earth like a cannon shot on the night in question, and which do not seem to bear the slightest relationship with those strange transparent fire-mists, called comets, through which every star beams as brightly as though there were nothing between us and them, and whose weird and phantom shapes, successively adopted, stretch themselves across the sky—now as a flaming sword,—now a glowing gas fan, now as a dim, hazy, tailless mass of

* This was visible to the writer in a remarkable manner in a comet which appeared in August, 1853, and which he observed most closely with a ten-feet refracting telescope of six inches aperture; continued flashes like those proceeding from an aurora or electric battery, or resembling what is called sheet or summer-lightning, played in the envelope of the nucleus, lighting it up and darting down along the tail. The nucleus itself was not condensed but semi-transparent, and the whole comet appeared like a hollow gaseous object. It was while engaged in observing this comet a strange object appeared in the zenith, and stretched itself across the heavens like a serpent, occupying two-thirds of the entire hemisphere. It was of a blue light, in some degree resembling that of an aurora, but in other respects not the least like one. It remained in view steadily and with equal lustre for nearly a quarter of an hour, when it gradually faded away. There was no coruscation or movement of light perceptible in it, and its breadth and strange serpentine form winding itself across the heavens would, a century ago, have been looked upon as most alarming. What its nature was I was unable to discover. There was a sketch of it, which appeared at the time in the *Illustrated News*, and it was evidently not a local object, but one visible throughout Great Britain, if not elsewhere. As the Russian war broke out before the year was out, superstitious people would see in these two-fold signs in heaven the indication of its approach.

nebulous light, now as a three-tailed, or even six-tailed, monster—flaming every way. All this seems to imply that, be they what they may, they are of a material unlike anything of a metallic or planetary origin, and are of so light and cloudlike a nature, that they are as easily acted upon by the agencies around them as smoke by the wind, or a soap bubble by the breath.



Meteor seen over Dublin, August, 1853.

Though there does not appear to be any connection as to the matter of which comets are composed, and those strange systems of meteors or star showers, yet it is possible they may be associated with such systems in other ways, and for other purposes. Thus it is possible they may be the travelling reservoirs or dispensers of magnetic or electric power, and may, in their various

orbits or courses, be as the sun and stars are in their own systems,—feeders of magnetism and electricity to the universe. They do not themselves indeed seem to possess any attractive power so as to influence the more solid bodies of the universe in this way; on the contrary, they are themselves subjected to the powerful attraction of our larger planets, Jupiter, Saturn, and Uranus. It is evident, however, that within their own substance there is something strongly resembling the phenomena of magnetic or electric force and action, and as dispensers of this they may possibly be of importance. As to their association with star showers, as yet, at least, it appears to be limited to a few, and this association therefore may be but the chance falling in of these light gaseous bodies with such streams of meteors as those of August and November, along which they might be borne as a boat is carried down a rapid stream. But the whole of the subject of this association is so involved in mystery that conjecture is vain, and the above suggestion is only given for what it may be worth, until future discovery shall have at length solved it fully.

In the meantime another and recent apparent association of Biela's comet with a stream of meteors has occurred, which adds to the interest of the subject; but which, although it has not yet served to clear up the mystery, has added another item of evidence in favour of the theory. On the 27th of November, 1872, at seven o'clock P.M., the writer witnessed a magnificent shower of stars. This shower, which he first imagined to be that, or part of that, which was due on the 13th, and which for some unexplained cause had been retarded, he soon perceived to be a different stream,

having a different origin, and seeming to proceed from a different quarter of the heavens from the November shower of 1866, which latter came from the star Alpha Leonis, in the constellation of Leo, from the north-east, meeting the earth in its course; whereas this shower appeared to come from the neighbourhood of Andromeda, from a much greater height, and rather from behind the earth's course. This circumstance at once distinguished the two systems to the writer. The latter shower appeared likewise to be resolved at a more distant point from the earth, although in other respects the phenomena were identical.

While debating in his mind to what to refer this shower, a report reached him that a German astronomer who had witnessed it had announced that this shower was but the stream associated with the comet known as Biela's, which has a period of $6\frac{3}{4}$ years, and whose perihelion was calculated for October 14th, but which could not be discovered at the time or place where it was due. Taking, then, the direction of the shower, and by it calculating the probable place of the comet, the astronomer mentioned communicated by telegraph with Mr. Pogson of Madras, requesting him to look for the comet, which by observation of the associated shower of meteors he assumed should be seen there, though not visible in Europe. Accordingly it is related that after two nights' vain search, something resembling Biela's comet was discovered by Mr. Pogson in the place described. The particulars of this observation have not yet been made known, but in the meantime grave doubts have been raised as to the identity of the object seen by Mr. Pogson with Biela's comet; and until this

is ascertained beyond doubt no definite opinion of this strange matter can be formed. The following passage from the *Athenæum* of January 18th, 1873, thus comments upon the matter:—

"Astronomers do not universally indorse the idea that the object discovered by Mr. Pogson on the 2nd of December was without doubt the lost comet of Biela. All that is certain is that Mr. Pogson turned his telescope on the track of the retreating meteors of November 27th, and saw an object of *cometary appearance*. If really Biela's comet, something very extraordinary must have happened to that body, which, according to the very accurate calculation of its path, would have been in perihelion on the 14th of October, whereas the group of meteors which produced the shower seen here on the 27th of November did not arrive at its nearest distance from the sun till the 25th of December. The earth crossed the orbit of that comet with which the meteors appear to have so remarkable a connection on the 27th of November (the night in question), but the comet itself was far away unless some catastrophe had occurred to it since last seen (concerning which speculation is quite at fault). It is more likely that what Mr. Pogson saw was another concentration of cometary matter in the orbit of Biela."

The probability of the correctness of this last suggestion is confirmed by the writer* of an elaborate and able article on the star shower of November and star showers in general, in the January number of the *Cornhill Magazine*, while in the mind of the present writer, likewise, it confirms the theory which he has himself already suggested in these pages,—that these objects, such as Biela's comet and Enke's, should not be classified or considered identical in matter with the greater comets, but are to be looked upon simply as clusters or

* The writer was Mr. R. Proctor.

aggregates of the matter of which the star showers are composed ; in fact, what Mrs. Wärd beautifully and poetically described as "the GEM in the ring" of star showers.

But the suggestion in the *Athenæum* seemed to be confirmed likewise by the statements of the writer in the *Cornhill*, who asserted positively that Biela's comet had *disappeared entirely from the heavens*, not having been found where it should be at its perihelion on October 14th, notwithstanding the most careful scrutiny



by Mr. Hind and other eminent searchers for the last two periods. He also suggested that probably a catastrophe had occurred to it which will prevent its ever resuming its place in its orbit, and that it will never be seen again. In a few days, however, after this paper had appeared, and subsequent to the star shower of the 27th of November, Mr. Pogson is said to have seen it in quite a different place from where it ought to be, and apparently uninjured by any catastrophe, and this just as the uninitiated readers were beginning to form their

own conclusions, and to suppose that the star shower of the 27th of November was neither more nor less than the débris of the comet of Biela, into which the earth had come in contact.

Now, how are these contradictory statements to be reconciled? In the one place, Biela's comet is reported dead, smashed to atoms ; in the other, alive and well as ever, only having taken a trip for its health or amusement to Madras, leaving a tail behind it to tell where it was gone. The eccentricities of Biela's comet, and its strange performances in another way, may perhaps render the latter achievement less wonderful. It is well known that Biela's comet some twenty years ago split in two, and the two comets thereby created travelled amicably together like a pair of coach horses, side by side, occasionally exchanging flashes with each other, for a whole period of seven years. Since that they have never been seen, till being searched for in October, 1872, and nothing found but their wake of star showers when they crossed the earth's orbit on the 27th of November, lo and behold, suddenly *one* appears at Madras,—as we have seen a duck in the water when pursued by a dog, making a long dive and coming up a long way off, leaving its pursuers completely bewildered and baffled. In the meantime, however, the real *dénouement* is anxiously looked for by those interested in such subjects.

The association of comets with meteors is illustrated in a curious manner by a vision of St. John in Revelation xii. It is believed by many that St. John had a comet before his mind's eye, in vision, when he says, in the third verse, "There appeared a wonder in heaven.

Behold a great red dragon, and his tail drew the third part of the stars of heaven." By the dragon, which is equally translated serpent, St. John means Satan, who is called in the same book "the old serpent, which is the Devil."

Now, the appearance of comets in the heavens has frequently been compared to that of a serpent. Thus a work of the sixteenth century,* describing comets, says, "There are some comets that bristle with twisted serpents, another draws after it the twisted folds of a long tail." The likeness to a serpent is indeed that which suggests itself most readily to the mind on seeing the long tail of a comet, which is frequently twisted like a serpent. Probably this, brought to the mind of St. John by "The Spirit," was used by him as an illustration of Satan. But in this case the celestial serpent, or Satan, was accompanied in the apostle's vision by stars, which he is represented as "drawing to himself,—even the fourth part of the stars of heaven." Here then is a vision, associating stars with a comet, and illustrating by it the presence and power of Satan. Now, have we any evidence that St. John might have himself seen such an association of stars in the presence of a comet as, impressing his mind, may have led ultimately to this magnificent description of Satan in his vision thus illustrated. According to the calculations for the return of the November star shower of 1866, reckoning back from that date fifty-three periods—of thirty-four years each—we should arrive at A.D. 64 for the appearance of the same system in the heavens. Now, it is remarkable

that it is recorded by Seneca, in the month of October, A.D. 64, a comet appeared "from the north by the west;" and it is more than probable this comet continued visible for the succeeding month of November. Here then was the simultaneous presence of a comet and a star shower in the heavens at the same time; and if this shower proceeded from Leo, or was in fact our Leonides, or November star shower, of which there is little doubt, then the effect would have been just what St. John describes in his vision,—the apparent drawing of the stars of heaven from the north-east by the comet to itself in the west. St. John, it must be remembered, was himself alive at the time referred to, and probably witnessed it.

Josephus refers to the appearance of what he calls a flaming sword in the heavens about the same time, A.D. 65, possibly the same comet that first appeared at the close of the preceding year, and appeared to St. John in the form of a serpent. This is brought forward not as a positive proof, but rather as a curious possibility of scriptural evidence of the remarkable association of comets and star showers.

But the able writer of the paper on meteoric showers in the *Cornhill* advances the theory that we must be prepared to believe that all meteoric showers and all comets must be derived from the large immatured planets of our system in a sun-like state, and with which space is filled; and that these bodies could have no other origin, but must have been shot out of their parent suns or planets, their orbits depending on the direction of the discharges, together with the attractive influence to which they are respectively subjected by other

* "Souciet."

planetary or solar bodies. And a most ingenious theory is adopted as to the power of our greater planets to arrest or entangle, or prevent the entrance of, foreign star systems or comets that would come to us from without—from the interstellar space, and which derive their origin from other suns and systems,—and the possibility of which the writer doubts. Yet of all this there does not appear to be a shadow of proof that can be considered satisfactory. Questions like these are beyond our reach; they are among the secret things that belong to God. The great fault of the present age, and of scientific writers, seems to be to find in secondary causes alone sufficient to account for what belongs to the First Great Cause and His *immediate* agency on matter; in fact, *creation by the Creator*. This is plainly beyond our faculties and knowledge. Who, for instance, can penetrate the mystery of the creation of our own globe or any planet in the heavens? They challenge us to explain their origin from their beginning to what they now are,—to explain their varied motions and the nature of the power that impels them on their course, or, having fixed their axis, preserves their inclination permanently in it. Many ingenious theories have been brought forward, it is true, to explain all this by secondary agencies, but no one has answered such questions beyond certain definite boundaries, except by guess. So with star systems and comets and all the matter with which space is doubtless filled. It is but waste of time and thought to attempt to account for their origin by secondary causes. How, for instance, does the theory assumed by the writer referred to, “that comets and star showers *must* have been derived from

other stars or planets,” clear up the difficulty? Supposing that it was the case, it only removes the mystery another step, and leaves us bewildered. The question still recurs, From what were the stars or planets themselves derived? Did they each produce themselves or each other, or were they each shot out of each other?

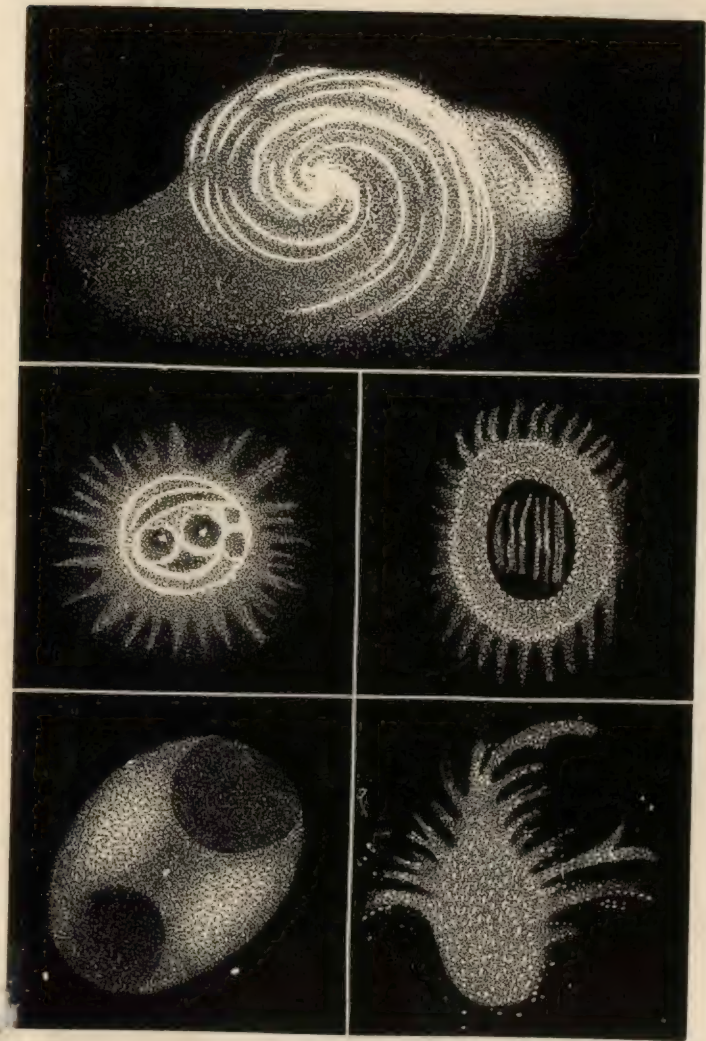
Must there always be something visible from which another something visible is to be derived? The Apostle tells us, on the contrary, that “the things which are seen are not made of things that do appear;” or, according to another reading, “are made of things that do not appear.”

Such I do believe to be the case of comets and star showers. They are independent races that owe no parentage but God, and have their own peculiar functions to discharge, which we know not; but they are not made of anything which we are enabled to see; we cannot trace their pedigree. There is, in truth, but one answer to all inquiries as to the origin of such bodies, which will serve as well for comets and star showers as for suns, and stars, and planets: “He made the stars also.” While we willingly allow that the Creator works through secondary causes, and has graciously permitted us to investigate many of these to our delight and instruction, He has not admitted us to His creative counsels, nor permitted us to go one step beyond the limits He has assigned to our knowledge and experience of those facts of which we may be cognizant without presumption, and which have been positively ascertained.

CHAPTER VII.

NEBULÆ: AND THE SYSTEM OF THE UNIVERSE.

AMONG the strange objects revealed to the eye in the heavens, the nebulæ may be considered, next to comets, the strangest and the most mysterious; and to the astronomer, perhaps, in reference to the system or plan (if it may be so termed) of the universe, of which they appear to be the indicators or sounding lines, the most interesting and important. Faint blueish misty clouds, hence called nebulæ, of definite form and shape, standing generally, as it were, aloof from every other celestial object, as though they did not belong to their companion stars around them, from the midst of which sometimes their pale mysterious forms may be seen looming and looking downwards, of every strange and fanciful shape,—now as a huge planet, larger than our full Moon, surrounded by a misty envelope; now as a faint ring, with black or white centre, or a double ring, each intersecting the other; now as a huge whirlpool of pale light, with concentric rings one within the other, or a spiral form like ostrich feathers, uniting in the centre and blown round by the wind in the same direction, like the bent sails of a windmill; now even a human face of misty light, with eyes and nose and mouth



NEBULÆ.

1. Spiral Nebula, in Canes Venatur. Lord Ross.
2. N in Ursa Major. Lord Ross.
3. Dumbell, N in Vulpecula. Sir J. Herschell.
4. N in Lyra. Sir J. Herschell.
5. Crab Nebula, in Taurus. Sir J. Herschell.

To face page 350.

of pale blue, and surrounded by bristly hair, actually peers at us out of the depths; sometimes too of a straggling undefined form, as that vast one in Orion, with patches of varied light; now a huge *crab* walks the shoreless sand of heaven, and spreads its legs of light on every side; now we have a dumb bell; now a beautiful *garland* of flowers, which resolves itself into stars of many colours,—but one and all of such an enormous size, compared to the largest or most brilliant star in the heavens, as apparently to separate them from those bodies entirely as a class. To Sir William Herschel is owing that some of the mysteries attached to these strange bodies are cleared up; and on examining them with his powerful telescope, numbers of them were straightway resolved into myriads of stars like those around them: in short, what appeared to be a separate firmament was disclosed. Some of them, however, did not yield even to the power applied to them, and to these Sir W. Herschel gave the name of irresolvable *nebulæ*. And here an ordinary observer would have concluded that it was only want of power in the telescope that prevented these last from being resolved like the others into their component stars. Sir William Herschel, however, did not arrive hastily at this conclusion, but by certain *indications* which his wonderful power of observation and experience enabled him to remark, he came to the conclusion that the cause of the irresolvability of many was, not their greater distance, but the fact that all were not firmaments of stars, but some were gaseous bodies. He was enabled, however, to come to a conclusion in his own mind, from his observations of these bodies generally, that they revealed the system of the universe

in infinite space; which was not, as was or might be supposed, an infinite or vast continuance of stars, but a possibly infinite number of separate star systems or galaxies, each constituting a *vast island of stars or suns*, so to speak, in the heavens, and separated from each other by such *enormous distances*, that the aggregates alone could be perceived as a faint misty light, until resolved by the highest power of which the telescope is capable. This system of the universe was recognised and adopted by astronomers universally, to the present day, with the exception of the question whether any of those termed by Herschel *gaseous* in nature, *were* so, and were not rather *more distant*, and hence irresolvable nebulae.

This question was agitated much about twenty years ago, when Lord Rosse's powerful telescope resolved many which had been irresolvable by Sir W. Herschel's forty-feet telescope, and appeared to countenance the fact that there were no nebulae to which the term gaseous could be applied; all were firmaments. This supposed discovery, however, did not affect the general question of the system of the universe as laid down by Herschel; and so matters continued until the discovery of the spectroscope, when the whole fabric thought to be established by Lord Rosse's telescope, again fell, and the positive existence of many gaseous nebulae has restored the original theory propounded by the sagacious Herschel, so far as that fact is concerned; but it has remained for the present age now to question even the reality of the system of separate galaxies suggested by the great astronomer on the testimony of nebulae, and to bring forward the nebulae themselves as witnesses

against the theory. A new system of the universe has been propounded by some modern astronomers* by which, at all events, these bodies to which Herschel had assigned a post *far remote* from the galaxy or system of stars in which he believes us and our own sun analogically to be placed, are now said to be far nearer to us than even the supposed boundary of our star system. If this be the case, it is plain that, so far as the nebulae are concerned, they are no evidence of the system of separate firmaments,—separate from each other by inconceivable voids,—as constituting the system of the universe: although it is possible that such is the case, the nebulae, at least, are no evidence of it. According to Mr. Proctor, the nebulae are members of that family of stars in the midst of which we are placed, and the extent or boundary of which we cannot see, and are by no means the most distant bodies from us. Some of them, the gaseous ones, being possibly much nearer than was supposed, while the components of the resolvable nebulae are plainly nearer than many in the milky-way (the supposed boundary of our system); and the evidence of the probability of distant separate galaxies in space, is reduced to those that are still irresolvable, and of which we can pronounce nothing,—but which *possibly* may be *outliers* on the verge apparently of our milky-way system. The argument has been thus stated: "If it is a fact that in that part of our own galaxy called the milky-way there are many clusters of stars so distant that no telescope can resolve them, how can it be conceived that nebulae, removed beyond that zone by

* Vide Proctor's "Other Worlds."

an inconceivable gulf, can yet yield their resolution into stars, to the very same telescope and power which the others resist." There is certainly much truth in this, and as regards the existence of *nebulae* (so called) or clusters *within* the zone of the milky-way there can be little doubt; nevertheless it still remains to be proved that *some* of the *irresolvable* *nebulae* are not outlying firmaments beyond that zone, and if so, the theory propounded by Sir John Herschel will still be unaffected by it. But what system of the universe can be proposed in exchange for it? There are but two ideas that can be supposed upon the subject, and under the circumstances either must be a supposition, and neither may be the truth: viz., that infinite space is *continuously studded over* or *furnished with* stars; that it is an *infinite* but irregular shaped continent of stars,—not, like our pacific, an ocean with *separate islands*. Hence what we see of our milky-way and system of stars around us would be, on this principle, only a *fragment* that reaches on for ever through infinity. We certainly cannot sound the depths of the milky-way with any telescope, therefore no one can assert that this *may* not be the case. The other supposition is, that there is a definite termination somewhere to the star region to which we belong, and a dark infinity beyond them. But this last thought is not either *probable* or *pleasant*, and can never be *proved*. God is light, and in Him is no darkness at all,—and it is much more *probable*, as well as agreeable to believe that in His universe there is no untenanted part. These, however, are questions too great to be answered by man, although full of interest. Nor is it after all of much importance

in looking at the strange misty forms that peer with blue ghostly look through the bright stars among which they *seem to be* placed, whether, they are so distant from them as to form distinct *islands* of glory, *altogether separate from our system*, or are themselves clusters and firmaments *within the boundary* of our *supposed galaxy*,—bright spots *themselves* on the infinite *continent of glory* of which our system is only a part. It will be seen, however, that while the *nebulae* are *thus indicators of the vast extent* of the starry system around us,—*sentinels* and *outposts*,—as well as sounding plumbs of the gulf above, their own constitution is not affected by their position; they are still, each of them, clusters or firmaments of stars, or gaseous bodies, the latter possibly the material from which the Creator formed all alike, for they are to be found, as Sir W. Herschel showed, in different stages of maturity,—stars from one to hundreds mixed up with a nebulous mist that conveys the idea of a partially formed firmament.


The number of these *nebulae* or clusters are now computed at 2306, as in Sir John Herschel's catalogue of 1833. When resolved by a powerful telescope, they are the most magnificent objects the eye of man ever beheld. To be a spectator of ten thousand suns congregated together, constituting a *mass of glory* that is inconceivable, is a privilege for which man might well be thankful. But for the telescope this could not have been done; but armed with it we are able, in some measure, to *contemplate future glory*. To see the *nebulae* with the naked eye, or a small weak telescope, is like "looking through a glass darkly;" but with a moderately powerful instrument we can be admitted to the sight of

celestial glory of which we could have had no conception. We can enter and look around, as at the heaven of heavens, the very abode of God Himself, which could hardly be brighter; wherever we turn the eye to the circumference of the wheel of glory, splendour surrounds us. Thousands of mighty suns beam upon us from every side, while a condensed blaze of them issues from the centre. But this is not all, for even with the highest optical power not one half its real glory can be seen. The imagination must picture for every sun there a train of planetary worlds, unseen by mortal eye, by hundreds and thousands, winding in and out amidst the star-mazes around, with the same order and beauty and varying colour as in our own solar system, doubtless each bearing on its surface its own freight of life and intelligence; angels and other glorious creatures possibly passing from world to world in that city of stars, as we should from house to house in our terrestrial cities: giving us a glimpse, at least, of the glory that awaits us hereafter, when from our little dark earthly chamber here below we pass to the lighted chamber in the palace of heaven above, and to Him who, while He "buildeth His stories in the heavens," ruleth alike over the armies of angels and inhabitants of earth below.

CHAPTER VIII.

"CONSIDERING THE HEAVENS."

PSALM VIII. 3.

UR journey through the second heavens is now ended, and imperfect as the survey we have made of it has necessarily been, in our rapid flight amidst gigantic suns and systems, steering our way among rolling worlds and wheeling comets, and entering dazzling clusters of glory,—yet so far as we have gone we have obtained, if not a perfect picture yet, at least some idea of a portion of infinity which may serve as a probable specimen of what lies out far beyond our ken in the endless regions of space. We have so far "considered the heavens" as to know something of its material nature and constitution; but there is another kind of "considering of the heavens" which we have not more than barely touched upon,—viz., the religious consideration; and which, as it is the most important, so it is naturally and irresistibly associated with the former in all minds not depraved by the prevailing prejudices of scepticism, and false philosophy of the age, which would separate what God Himself has joined inseparably, viz., science and religion, and would maintain the absolute necessity of studying the former as though the latter did not exist and had no connection whatever with it.

While protesting against such a perverted use of the faculties with which God has endowed us, by which we exclude the Creator from His own works, and thrust Him (while considering them) as it were from His throne,—looking at it even in a worldly sense, it cannot be considered otherwise than highly unphilosophical to restrain the natural working of the human mind which, sinful as it is, would, if left to itself, seek its Creator in what He has created, and desire to be led “from nature up to nature’s God.” It must always indeed be with an *effort* that this is *not* done, for notwithstanding that the natural disposition of man does not incline Him to seek God, yet the wonders of creation alone *will* force upon his mind the *thought* of a Creator, so powerfully that it requires some violence to our feelings, an artificial effort, and great self-restraint to *keep it out of* the untutored mind. And even the scientific esprit de corps, by which so many are led in the present day, which animates the so-called scientific world to pursue their researches in the different branches of knowledge *without God*,—i.e., without any reference to Him, without connecting the presence of the Governor of the universe with any of them, and so to wrap themselves up in their study of the universe as to ignore His existence,—even this is sometimes found insufficient to banish Him from the mind. Many of the problems of nature, in fact *will only* find their solution in His direct and active agency, however reluctant men may be to acknowledge it.

Granting, however, that some men, however erroneously, yet conscientiously, think that science and religion should never intermingle with each other, but

that each should be followed and studied *separately*; and that the most important doctrines of religion,—such for instance as the creation, the antiquity and fall of man, or the deluge, or the great age of the antediluvian patriarchs,—should never be permitted to move a stone of the philosophic building which science has erected upon these subjects. While doubtless there are many who think thus as regards the interference of religion with scientific dogmas, or so-called discoveries, yet, setting aside the impossibility of believing two opposites, which would be the consequence of such doctrine, the theologian who acknowledges the right of the scientific world to pursue their own course unmolested, may fairly complain that in the present day at least *he* is not permitted to pursue *his* study undisturbed, any more than he is permitted to explain, or even to attempt to reconcile his theology with the deductions of science. On the contrary, while many of the scientific world, so-called, refuse to listen to the testimony of the Bible, which they yet *profess* to believe to be the Word of God, in explanation of or in opposition to some of their discoveries or interpretations of nature, they themselves freely use those discoveries or supposed interpretations for the overturning, on very insufficient grounds, of the most important or most cherished doctrines and truths which the theologian rests upon: this is not what in England would be called “fair play.” If men *are* to study science and Revelation apart, according to modern ideas, let them do so; but in that case, if Revelation is never to be used in opposition to or in conjunction with science, then let science, on the other hand, never be used in

opposition to or in contradiction of the revealed Word of God. The truth is, however, so long as this principle of unholy separation in the study of these branches of human knowledge shall be continued, men will always be found to range on opposite sides, and the educated man of pure science will almost invariably be found in antagonism with the theological statements of Revelation,—not because they are really at issue, but because he may be unable to reconcile many of them if he has made science his study, not religion; because he is ignorant of the latter, or at least superficially acquainted with it, while to the former he has given all his faith and all the power of his intellect. *In truth*, the doctrine of the necessity for a separate theology of the book of nature and Revelation will never produce any other than a divided result; through a narrow-minded bigotry on the one side, or an unreasonable animosity on the other. Yet the admission of the claims of both Revelation and science to be heard by the thinking mind of man, as two witnesses given by God to the same great truths, even though we may be unable to reconcile them, must be productive of good; for if, on the one hand, science sheds its own light on the great facts of the material world, as interpreted by the wisdom and laws of men, the Bible sheds its own and peculiar lustre on man's discoveries, and, at the same time (as the drag upon the wheel of the descending carriage) it checks the sometimes too presumptuous course of man's wisdom and reasoning, proving that in not a few cases the wisdom of man is but foolishness, and the foolishness of God the highest wisdom of man. (1 Cor. i. 25.)

But what is the impression which the religious con-

sideration of the heavens leaves upon the mind? The Psalmist describes such impression by his own experience thus: When I consider the heavens, *the work of Thy fingers*, the Moon and the stars which *Thou hast created*, Lord, what is man that Thou art mindful of him, or the son of man that thou takest knowledge of Him. There are two thoughts here expressed: a sense of the greatness and glory of creation and admiration of the Creator and His work, with a deep sense of his own insignificance; and there is the religious or moral impression left on the mind of any pious man, which is quite different from the mere *material impression* left by considering the phenomena of the heavens and the heavenly bodies, however wonderful and curious that may be. That indeed may be all explained and done with no more religious feeling, or moral sense, or reference to the Creator, than in doing a sum in arithmetic. Many astronomers, indeed, are no more than *arithmeticians* and calculators of what they see; but the highest powers of calculation, such as are found in such men, have nothing whatever to do with the moral or religious sense.*

* Mr. Proctor seems to think (erroneously as I conceive) that the religious consideration of scientific subjects (such for instance as astronomy) necessarily involves the expression of the writer's *individual religious* opinion, and excuses himself for the non-introduction of the religious aspect of it, in his otherwise admirable essay upon "Divine Control and Supervision," upon this ground; adding, that no one could feel it to be a matter of importance what his own *individual religious* opinions were, and therefore the religious view of such questions should be avoided in scientific discussions. In corroboration of which he refers to Bacon, as recommending silence upon the subject of religion, because "there can be no alternative between accepting the deductions of science without question, or putting ourselves on board the 'Ship of the Church,' and being directed by the

But what, again let me ask, is the impression which such a journey as we have made through the second heaven leaves upon the mind open to conviction, and not prejudiced by the principle of a false philosophy against the *religious* consideration and aspect of the spectacle of the heavens?

infallible doctrines it teaches." But, with all deference to Mr. Proctor's view, and also to the high authority he quotes, I cannot but differ from *both*.

As to Mr. Proctor's view, that the *religious* aspect of astronomy is necessarily but the *private view* of the *individual* on the subject of religion, a moment's reflection will show its fallacy. The opinion of an individual cannot affect the Revelation of God, as contained in His Word, any more than the opinion of man can affect the light of the sun,—which will give its light, and continue to be what it is, notwithstanding all the reasoning of men concerning it, or the opinions they hold about it. The declaration, therefore, of what God has said in that Word concerning His creation, is not the expression of the opinion of the individual, but the Creator's own statement, with which he has nothing to do but to declare it; and with which neither Mr. Proctor nor any other man has anything to do personally, and for which they are not responsible. The *truth* is *there*, if there was not a man to *declare it*. Hence, although a writer who takes the religious aspect of any branch of science will naturally be credited by his readers with a belief in the Bible, it is only a belief that is shared in by millions, and should not be set down as the *peculiar* faith of the writer. It is such a faith as that the sun rises and gives the world light, and which is not affected by any opinion as to its being a delusion. As to Bacon, I am happy to think, it is *only* with his *conclusion* that Mr. Proctor agrees, though even there I differ with him: viz., the propriety of *silence in religious matters* in the consideration of scientific subjects; but he as distinctly disavows,—as any one who would maintain the right of private judgment in religious matters *must*—the premises on which this erroneous conclusion is founded, viz.,—the *infallible* dogma of the *Church*; between the entire acceptance of which, or the deductions of science, Bacon gives no alternative. In other words, to be a scientific believer (according to his notions) is to *forsake* the ship of the Infallible Church, and be an infidel; or, *vice versa*, to be a Christian, is necessarily to be, in *his view* of religion, an opponent of science, for they are incompatible. But what kind of Christianity is it to which Bacon refers by the ship of the Church? There is but *one* that answers the picture, and that one no Protestant Christian will be found embarked in. The fact is, that true Christianity which asserts the right of private judgment, is not in antagonism to science; they have one *Author* and one *object*: to *proclaim the glory of God*. And though they may be set

Awe and admiration would appear to be the prevailing sensation, at the power and grandeur of the spectacle of the infinite heavens,—and admiration at the wisdom and skill and order which is there discernable. Thus, amidst the lightning-like speed of millions upon millions of glowing suns not one has been ever discovered a hair's breadth out of its proper place! Amidst the terrible swiftness of constant motion, not only is there no collision of sun with sun, or planet with planet, but to the eye of the beholder all is calm: no mistake or error can be detected; no wandering of a single orb out of its sphere! The control is perfect, and, so far as we can see, collision is (humanly speaking) an impossibility. Swift and tremendous, too, as are the commotions (as we have seen) beneath the burning bosoms of each of the millions of stars that meet the eye, and which are really vast orbs of molten fiery metal, like our own sun,—yet to the eye of the spectator, removed as he is in every instance to a safe distance from it, all is calm, peaceful, quiet: perfect beauty reigns! The heavens repose by day or

down by some as *two* barks, I should prefer their being but different parts of the same *one* vessel; yet, if two, they may sail as amicably together, side by side, as two companion vessels belonging to the same master, built by the same builder, bound on the same voyage; and exchange many a joyful hail, and many a word of inquiry, and greeting and sympathy, one with the other, to *cheer* and *comfort* the respective crews, as it were, without any such *sacrifice* as is demanded by the great *Philosopher*, as unnecessary I think as it is *untrue*. The following is the passage referred to by Mr. Proctor,—“If we were disposed,” says Bacon, “to survey the realm of sacred or inspired theology, we must quit the small vessel of human reason and put ourselves on board the ship of the Church, *which alone possesses the Divine needle for shaping the course*. Nor will the stars of Philosophy that have hitherto principally lent their light be of further service to us, and therefore it were not improper to be silent upon the subject.”—*Advancement of Learning*. Book ix.

night, with a serenity and splendour that soothes while it awes,—with a peacefulness that quiets the mind when disturbed; though we know well that a near approach to any one of these silent glittering objects, and the thunder of its awful convulsions would fill us with unspeakable terror. But the perception of this order and arrangement, thus visible on every side, while it inspires a feeling of confidence that nothing *can* go wrong, for that everything we see is under irresistible control, leads us naturally at the same time to the thought of *design* and *intention* in it all. *That* design and intention, indeed, is as plain and is as perceptible in the mechanism of the heavens as in any piece of machinery made by human hands and human intention, and leads us as plainly to the great Designer of all things, as any ingenious and beautiful piece of mechanism here does to the inventor and artificer, as a beautiful picture or ship does to the artist or builder. This argument from design, so visible in the heavens and the earth (an argument so admirably used by Dr. Paley) at once fixes indelibly in the mind the certainty of an intelligent Designer; in other words, the personality or individuality of God, the Creator of all things.

It is against this doctrine of the individuality of the Creator that the arguments of sceptics and atheists are principally directed in the present day,—sometimes assuming the form of a pervading intelligence, that does all things, making *worlds* as well as men and *minds*; one does not know how or why,—for its intelligence is only seen or imagined in its development. Sometimes it takes the shape of a series of laws, which are a law to themselves; and are necessarily at once cause and effect,

for no origin is assigned to them, nor reason why they should be laws or regulators of the universe,—but that they are there without an author, a law-maker, or giver: it is a universe of law. And *that* by many is deemed to be a sufficient explanation of all that we see in the heaven as well as the earth; and that these laws are *invariable, unchangeable*, as well as universal and infinite: but no author appears on the scene,—no first cause! These are the two great features of the worst form of godless materialism, or as it should be termed, atheism. There are, however, many modifications of these, which do not go so far; but holding an equally feeble, vague and absurd idea of an intelligent and presiding mind, that has made certain laws for the creating or sustaining of the universe; but having done so, has left the world to develope and take care of itself,—as a man would a chronometer, or the maker of a machine of perpetual motion (if such a piece of mechanism could be conceived as possible) might do; when, having made it, he retired from it, and left it to work or take care of itself, never interfering or exercising further supervision over it.

Now against this and every other form of atheistic materialism, the very material heavens themselves, and every shining star there, *protest*; and the more closely they are examined the more strongly do they affirm the distinct personality and individuality, as well as unity, of Jehovah their Creator; the more plainly they confirm the statement of David, the inspired Psalmist, that “the heavens declare the *glory of God*, and the firmament *showeth His handiwork*,” the more clearly do they point to the great First Cause and *continued* and intelligent *individual* Governor of the universe,—who formed

the worlds, and sustains their existence, and regulates their movements. The unity apparent in the design perceptible in the heavens proclaims at once (what indeed it would be absurd to suppose otherwise) the distinct *personality* of the Designer; while the *power* and *wisdom* and *order* perceptible in the contrivance and carrying out of it proves that there is an all-*powerful*, all-wise, and *intelligent Being*, the sole fountain and origin of all creation, and all intelligences, of all *matter* and *mind*,—the Maker of all worlds: as Paul describes Him when he says, “the *invisible things* of Him (*i.e.*, His eternal power and godhead) are clearly seen, being understood (or interpreted, or apprehended) by the things that are made.” Here is a fair chain of argument,—upwards from *things that are made* and *clearly seen*, to the Eternal Power and Godhead that made them, and would not otherwise be seen. St. Paul, therefore, justly says of those who would deny this argument, that they are “without excuse;” and so doubtless all men are who shut their eyes to this great truth,—the keystone of all faith,—that God is a Person (not a *power*, or *force*, or *influence*), and that by this Person was made everything that *was* made, whether they be visible or invisible.

The mind armed with this truth surveys the heavens with very different feelings from him who seeing them sees only a beautiful and wonderful piece of mechanism. Thus in a recent work by one of the most accomplished and brilliant of our modern lights of science,—whose justly deserved fame is on every tongue, and whose original researches into the very depths of nature and the material world have gone beyond and exceeded all

his competitors in those branches of knowledge to which he has devoted himself,—he thus gives his view of the glory of the heavens; or rather thus expounds the beautiful and familiar passage in the Psalms, with which we are all acquainted: “When I consider the heavens, the work of Thy fingers, the moon and the stars, which Thou hast ordained; Lord, what is man, that Thou art mindful of him, and the Son of man, that Thou visitest him?” (Ps. viii. 3, 4)

“Transferring thought (says this writer) from our little sand-grain of an earth to the immeasurable heavens, whose countless worlds, with their freights of life probably, revolve unseen, the very suns which warm them being scarcely seen by us across abysmal space,—reflecting that beyond these sparks of solar fire, suns innumerable may lie whose light can never stir the optic nerve at all,—and bringing this conception face to face with the idea that the Builder and Sustainer of it all should contract Himself to a burning bush, or behave in other familiar ways ascribed to Him, it is easy to understand how astounding the incongruity must appear to the scientific mind. Under the pressure of the awe which this universe inspires, well may we exclaim, in David's spirit, if not in David's words, ‘When I consider the heavens, the work of Thy fingers, the moon and the stars, which thou hast ordained; what is man, that Thou *shouldest be* mindful of him, or the Son of man, that *Thou shouldest so* regard him.’” *

The interpretation or exposition of this remarkable passage, as thus given by Professor Tyndall, and adopted by him as a mode of expressing the feelings of awe excited by the spectacle of the universe as compared with our little world, is as different from the *spirit* as, it has been justly observed, it is from the *words* of David. The words of the Psalmist break forth in *wonder*

* “Fragments of Science for Unscientific People,” by J. Tyndall. (P. 147.)

and *admiration* at what God *has done*, notwithstanding the apparent insignificance of our world compared with the glory and grandeur of the heavens. The interrogative form in which it is expressed only serving to render the conclusion which the Psalmist admits and declares,—viz., that God *has been* and *is* mindful of man, and *has* visited him, notwithstanding his apparent insignificance in the matter,—more wonderful but not less certain. But Professor Tyndall's interpretation of this passage, whether intentional or not, leads to an exactly opposite conclusion: viz., that it is *impossible*, and a thing altogether inadmissible, that God *should* so mind and visit man. This is expressed by the alteration of the words *art mindful* and *hast visited*, which relates a *thing done* for *shouldest be* mindful and *shouldest visit*; suggesting in plain language what is inadmissible,—that such a thing is *impossible*. Yet if after all it be *not* a fact that God *is* mindful of man, and *may* visit him, there is an end at once to all *Christianity*, and for it is substituted a religion of materialistic Deism. How such an opinion can be held consistently with belief in the Bible or Revelation of God, it is not easy to see; and yet many men who do hold such opinions as these *still profess* to be Christians, and to revere and admire the Bible. But the truth is, no man can form a right notion of God further than He has made Himself known to us in His Word. "Canst thou by searching find out God? Canst thou find out the Almighty unto perfection? It is as high as heaven: what canst thou do? Deeper than hell: what canst thou know?" The moment we begin to reason upon the Divine nature, apart from what we are informed of it, we enter upon a boundless, shoreless, endless

ocean; and the moment we forsake the personality of Jehovah, as described to us in His Word, and in Christ Jesus, we are overwhelmed and bewildered. The attempt to determine what the Divine Creator *can* or *cannot do*,—*what He is* or *is not*,—*where He can be* or *cannot be* (as in the instance of the burning bush*),—*what He should* or *should not do* (as in the instance cited by the Psalmist), is, as God Himself says, referring to Job and his friends,—but "darkening counsel by words without knowledge." On the other hand, the personality and individuality of God is a doctrine so distinctly and plainly taught, and so easily comprehended, that the merest child can reason up to what may be known by them respecting Him: the words *Father*, *Saviour*, suggesting to us quite as significantly His providential care, love, and mercy, as the word Creator does His *power* and *wisdom*.

The *distinct individual personality* of the Creator then,—His personal presence in the universe which He has created, and His superintending providence over it, and His certain interference in it,—which as it has been truly

* There is nothing more wonderful in God manifesting His presence in a burning bush (referred to by Professor Tyndall as being an astounding incongruity to a scientific mind) than there is in His manifesting His presence in any of ten thousand ways He does in nature here, though without an audible voice,—unless the voice or nature through which He speaks in the wind, the thunder, the ocean, the volcano, the earthquake. These indicate His *power* and *agency* in the voice of *nature*. Through *man too*, and His organ of speech, and through the Man Christ Jesus, the impersonation of God, God speaks still more *fully and distinctly*, and with an audible voice. But will it be said that because God speaks in and through the body of a man He therefore necessarily contracts Himself to the dimensions of the *human form*? It is such philosophy as *this* that ought to be an incongruity to the scientific mind, and not the miracle of the burning bush.

said* is the doctrine of the Hebrew Bible, and that which Jesus Christ taught in the sermon on the Mount,—presents *the heavens* and all the host to the *consideration of the observer* in a very different aspect from that which is falsely termed “philosophic religion,” which presents but to the eye an infinity of glorious suns and worlds, and the perfect mechanism pertaining to them, but as a universe of matter without a creator, and laws without a law-maker, or at least “a pervading intelligence,” without a person or particular mind in which it is to reside,—as it has been truly said, is an agency without an agent, potency without power, sight without a seer, thought without a thinker, life without that which lives, and beauty, and glory, and wisdom, and beneficence, without anything further to produce them.† On the other hand, what a wondrous spectacle is presented by the heavens to him who has made a personal acquaintance, so to speak, with his God : with Him, the Creator of all he sees, who sits behind yonder glittering canopy as behind a curtain, holding every sun and every planet in His almighty grasp; the one *Maker, Ruler, Guider*, of *all things* and all men; who moulds alike, and by the same hand, the tear drop in the eye of man, and the gigantic form of Jupiter amidst the worlds above : without whose will even a sparrow cannot fall, nor a hair of our head perish, nor a world go astray in space, nor a lily of the field blossom, nor a sun give out its rays; and who, while He telleth the stars by name, bindeth up the broken hearts of His creatures. The thought that when we are beholding the heavens we there see the work

* “Aids to Faith,” p. 306.

† “Aids to Faith.”

of this gracious Being,—the work of God's fingers,—of God, who when He would convey to us the knowledge of Himself sends the impersonation of Himself in the Redeemer of man to visit *our* planet; to visit it in the *person* of One who was, not only all that was powerful and wise, all that was lovely in character, all that was tender and merciful in feeling, but, above all, One that was *human* and *humanizing*; assuring us thereby of the certain Personality as well as the godhead of the Creator, and also that as man was made in His image, so *from* and *through* man we are to derive our ideas of *God*; that therefore what is called contemptuously, by the mere materialist, anthropomorphism, is one of the grandest truths made known to man. That in truth and fact we are to regard God as a *man*,—a *perfect man*; as *He* was of whom it is said, though clothed in mortal flesh,—He was the express image of His Father.

Thus viewed, every planet and every cluster of suns and planets, is considered as part of the same gracious and beneficent and intelligent agency which we are familiar with not only in all *creation*; but in the *redemption* of man. The same power, wisdom, love, mercy, and tenderness, which was exhibited in the person of Christ when He walked on earth may be fairly assumed to extend through infinity; so that there is not a world formed by God that does not more or less partake of His bounties, and rejoice in His benevolence, as surely as it exists by His power and wisdom. But what an idea the spectacle of the heavens conveys to the mind of the Christian of the dominions of the Almighty! Give a family of worlds to every star we see, and to

the members of every cluster in the firmament, each revolving in their own orbits and performing their appointed tasks: people all these worlds with intelligent creatures,—clothe them with every glory and beauty of our own planetary habitation,—what a scene of grandeur is presented to the mind! What a God is ours, who rules over all these starry hosts and kingdoms and worlds,—which hang upon His smile, and depend upon His power, and look up to His goodness for existence and happiness! How many mansions in his Father's house may not the Christian astronomer thus number as he looks up at the calm repose of glory above him. How irresistibly the thoughts are led and the imagination wings its way to that Saviour who has ascended on high to prepare a place for His beloved people, who reigns high above the stars, in some glorious dwelling-place from which He will again return to bring His redeemed with Him.

Whither shall they accompany Him? To which of those celestial star-cities that gem the heavens shall they be introduced? Bright as a starry night appears to us here on earth, it will be naught to the splendour of the scene which we shall behold in those regions which the telescope can only faintly picture to us here,—those regions where no night exists. Bright as our own morning star appears, we shall see a brighter one there, while once more all the morning stars shall sing together, and the sons of God who beheld our planet burst into life and beauty, shall break forth into singing, and the *Second Heaven* shall rejoice.

APPENDIX TO THE SECOND HEAVEN.

JUPITER.

MR. PROCTOR makes light of the argument for the habitability of Jupiter and the other outlying moon-furnished planets, from arguments derived from the proportional supply of moons and moonlight, distributed to them according to their distance from the Sun, indicating thereby a deliberate design to compensate them for the comparatively feeble sun-light they are apportioned by reason of their distance. In the case of Jupiter and Saturn, at least, compared with the earth, this seems very *apparent*. While the earth has but one moon, Jupiter has four, and Saturn eight; the full number of moons apportioned to the planets Uranus and Neptune cannot be determined at present; but this is sufficient for the purpose. Sir W. Herschel and other astronomers saw in this arrangement (naturally I think) a wise provision for compensating light, as well as the other purposes which moons subserve, such as the regulation of the tides.

There was something like contrivance *here*,—and this we love to see: the hand of God doing what the hand of man, had he the power, would do too, and the mind of man suggest. I do not think the force of this argument for *design* and *contrivance* can ever be got rid of on the plea of our ignorance, as suggested by Mr. Proctor; nor do I think the circumstances that

are mentioned by him invalidate it,—shake it in the least. Mr. Proctor states that the argument is invalid because, in point of fact, the light of these planetary moons of Jupiter are not *compensating*, not nearly as bright as our own Moon,—first, from their great distance from the Sun, which would reduce their combined light to less than the light of our *full Moon* by the 125th part; secondly, that there “never can be (as some have imagined) four full moons visible together in Jupiter’s sky. They are so situated, in fact, that three of them must be eclipsed for at least two hours out of the five, and the shortness of their night, and the rapidity of their motion, leaves but a small modicum of light; while the fourth satellite, though not as often eclipsed, yet is frequently so. So feeble, too, is the small light they receive from the Sun, that supposing their reflective power equal to our Moon, the whole four combined could not send to the surface of Jupiter more than one-sixteenth part of the light we receive from our full Moon. It is in vain, therefore, to speak, as some do, of the splendour with which the satellites of Jupiter illuminate his skies; and those writers are mistaken who allege the great distance of Jupiter from the Sun is compensated by the number of his moons and the quantity of light they reflect towards him. So far from this being the case, under the most favourable circumstances, they can supply during the night of Jupiter but about *one twentieth* part of the light with which the full Moon illumines our nocturnal skies; and the poetical description which imaginative writers have indulged in respecting the splendour of the scene presented by these satellites will not bear the day-light of numerical estimation.

“That the satellite system of Jupiter subserves important functions, and affords in reality, like all the works of the Creator, the amplest evidence of design, need not be questioned; but that we have been able to understand the special purpose for which they have been created,—in fine to see as the Creator does, that they are good,—may be assuredly denied.”

I regret to be obliged to demur to the views of this able and accomplished writer, as here expressed, in some particulars.

And first, taking Mr. Proctor’s own acknowledgment that the satellite system subserves important functions and affords in reality, like all the works of the Creator, the amplest evidence of design, why should *this* first most obvious most *striking and evident proof of design* (*i.e.*, the furnishing a world with light, whatever be the quantity or quality or arrangement for distributing or apportioning it) be *excepted*? Poetic exaggerations are one thing, but facts are another; and surely Mr. Proctor will not deny the fact that one of the purposes these moons subserve is *to give light, of some sort, to their primary*,—just as our Moon does to us,—if not they might as well be dark globes, without any reflective power. Surely this lies on the very surface of their functions, if they have any; and a glance at them brings the instinctive conviction of it to the mind. The other purposes they subserve, and the functions they perform, although reasonably conjectured by comparison with our Moon, are hidden from our sight, and require the analogies of science to prove them; but “*seeing is believing*,” and one might as well doubt the intention of lamps in a street, or the purpose implied in a room lighted with four or eight candles in a chandelier, as doubt the main purpose intended in the moons of Jupiter or Saturn, which amounts to intuitive certainty. As to the light they give, in quantity or quality or continuance, that is another question; but even here I may suggest the possibility that science is not unerring in its conclusions: *i.e.*, in the application of general laws to particular cases. For instance, the moons of Jupiter, says Mr. Proctor, “shining with a light reflected from our Sun, be it remembered, can only shine with a light some twenty times less than that of our full Moon (*i.e.*, provided their reflective powers are only equal to that of our Moon);” but let me ask, who is to answer to us that their reflective powers *are* only equal to our satellite’s? There is, as it appears to me, not a particle of reliable evidence to prove it to demonstration; nor is there any reason for not thinking that the same wisdom that assigned to them the *purpose for which they were placed where they are* would not fit them and adapt them perfectly to fulfil that purpose; nay, setting aside the supposition and argument I have already advanced respecting

their *primary*,—viz., the possibility of the adaptation of the eyes of the inhabitants to the dimmer light in Jupiter, by larger pupils, rather than the adaptation of light to the eyes, which argument be it remembered applies as well to the reflected light of the satellites of Jupiter as to the direct solar light received by him,—yet it is an argument that seems scarcely necessary when we look at either Jupiter or his satellites, all of which appear equally and absolutely brilliant: the satellites (which Mr. Proctor, at least, will not say are minor suns) shining with apparently quite as much lustre as their primary; a lustre indeed, which, considering their minute dimensions and the enormous distance they are from us (500 millions of miles), is *wonderful*. If, then, they appear like brilliant diamonds to us, how can we suppose they are but *pale* weak moons, giving but one-twentieth part of our Moon's light to their primary? This would be carrying out the deductions of science to a conclusion respecting distant bodies, of which we can know but little, without leaving room for any exceptional circumstances. I confess I see great beauty and interest in the argument for design; in the arrangement first, I believe, assumed by Sir W. Herschel,—that the Creator has lighted His worlds with a proportional and compensative view to their locality; lighted them as a man would light a large room, with more lamps or candles than a small one,—as he would light a darkly situated room or house, with more windows than in a light position,—or as a railway train would be provisionally lighted with lamps that had to pass through a dark tunnel at certain periods; the compensating principle being above all others that which is most visible and striking in all departments of creation,—in the animate as well as the inanimate world, in the wonders of nature around us as well as in the mechanism and structure of our own bodies. And looking to the analogy of design in nature and art, in God and man, I confess myself to be among the number of those who, notwithstanding ingenious arguments to the contrary, question the power of any numerical or arithmetical calculation to overthrow the evidence for the compensating arrangement of lighting the planetary worlds, without stronger proof.

It is nothing to say (as Mr. Proctor does) that God has not let us into His designs, and that therefore we are not entitled to argue, or draw conclusions, from what we see in the *apparent* arrangement of those distant worlds, or seeming analogies with our own. Proofs of contrivances from design can only be inferred from what we see, and it seems to me to be perfectly legitimate to argue from what we see up to the probable design, without any presumption on our part, more especially when we have the analogy of our own case to bear us out. It might, with equal truth, be asserted that it was presumptuous to infer that there were any other planets beside our own, as to infer the nature and use of these moons from what we see of them. In truth, I look upon the light-giving powers of the satellites of Jupiter, however it be contrived, as quite sufficient for the purpose for which they were intended: viz., to shed a *sufficiency* of light over the scenes they were intended to illuminate. An examination of the different magnitudes, distances and movements of these bodies, will perhaps assist in giving an idea how far such a view is reasonably confirmed.

The first satellite, or that nearest to Jupiter (named "Io") has a real diameter of 2,440 miles, and accordingly has an apparent diameter to us about the size of *our Moon*.* Its distance from its primary is something more than the distance of our Moon from the earth, being 278,000 miles. The time of its revolution, as with all these Jovian satellites, is much more rapid than ours, Io performing her revolution in forty-two hours, or less than two days. This moon is always eclipsed when full: *i.e.*, at the expiration of this short period.

The second satellite (*Europa*) has (according to Guillemin) a diameter of only 2,190 miles, and is the smallest of the four, its distance being 443,000 miles. Its *apparent* diameter will be not more than about *half the size of our Moon*; its period of

* The distance of the Moon from the earth is 240,000 miles.

revolution being something longer than the first, or three days, thirteen hours, fourteen minutes.

The third satellite (*Ganymede*) has a diameter of 3,579 miles, and is the *largest* of the four, approaching to within 500 miles of the magnitude of *Mars*, and exceeding in volume the planet Mercury by two-thirds. Its greater distance, however, from its planet (707,000 miles) will reduce its apparent magnitude to about the same as the second satellite: viz., *half the size of our Moon*. Its period of revolution is *seven days, three hours, forty-seven minutes*. These *three satellites* revolve round Jupiter in planes but little inclined to the planet's orbit, so that at each revolution they enter and pass through his conical shadow, causing to themselves an eclipse of the Sun and to Jupiter an eclipse of his satellites. From the earth we can distinctly see their disappearance, or immersion as it is termed, in his shadow; also their reappearance, or emersion.

The fourth satellite (*Calisto*) has a diameter of 3,062 miles, and being situated at a distance of 1,243,000 miles its apparent diameter will only be about one fourth of that of our Moon.

DIAGRAM OF JUPITER'S SATELLITES.

The *apparent* magnitudes of the four moons, as they would appear to the inhabitants of Jupiter are as follows. They would see—



- | | | | | |
|----|---------------------------------|---------------------|---|-----|
| 1. | One moon only as large as ours | - Io | - | 1 |
| 2. | Two moons half the size of ours | - Europa & Ganymede | - | 2-3 |
| 3. | One moon one quarter the size | - Calisto | - | 4 |

APPARENT MAGNITUDES AS SEEN FROM JUPITER.

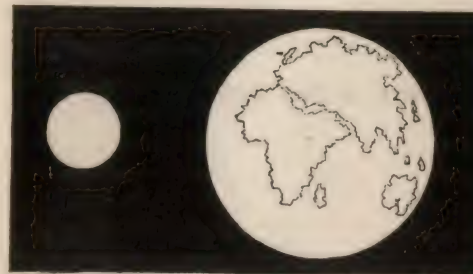


Diameters: 2440	2190	3579	3062 miles.
Io.	Europa.	Ganymede.	Calisto.

REAL PROPORTIONAL DIMENSIONS OF JUPITER'S SATELLITES COMPARED WITH THE EARTH AND MOON.

Moon. Diameter 2160.

Earth.



Its period (sixteen days, sixteen hours, thirty-two minutes) is the longest of the four, but still little more than half of *our Moon's*. The rapidity of its motion, therefore, as well as of all this system of moons, forms a strange feature in the Jovian sky. They pass so rapidly in their courses that their motion must be quite perceptible to the naked eye, going through all their phases as our own Moon does, only in an incomparably shorter time; the nearest satellite (Io), for instance, accomplishing each quarter in a *single day*, its short Jovian month being equal to but four days of ten hours. *The first day* from a thin crescent to a *half moon*; the second from a half moon to a *full moon*; the third from the full moon to the *last quarter*; and in the fourth returns to conjunction with the Sun. Thus the motion of this moon will be as if our own Moon moved over a space equal to her own apparent diameter in less than four minutes; this would be a kind of rushing through the sky that would be very *striking*. In like manner the second satellite would move over the firmament apparently with a rapidity the same as if we beheld our Moon moving around a space equal to nine times its diameter per hour, or *once* its own diameter in seven minutes.

The movements and changes of the other three are not so rapid, but still all move more swiftly than our own attendant, accomplishing their months of four, eight, seventeen, and forty Jovian days *respectively*.

END OF THE SECOND HEAVEN.

THE THIRD HEAVEN,

OR

HEAVEN OF HEAVENS.

THE THIRD HEAVEN,

OR

Heaven of Heavens.

CHAPTER I.

THE ASTRONOMICAL EVIDENCE.

"Caught up to the third heaven."—2 COR. xii. 2.

THERE are questions of deep interest connected with the thought of the relation which our planet, which is our present home, bears to that brighter and more perfect dwelling-place to which all Christians look as their final rest, termed popularly as well as scripturally—heaven. Assuming the fact that there is such a place or locality as heaven, adapted for material beings, and therefore necessarily material itself, the question recurs again and again to the thoughtful mind—What is it? and Where is it? Our Lord, as the Scripture tells us, and as we repeat in our Christian creeds, has "ascended into heaven," not as a *Spirit* (which, as He himself declares, "hath not flesh and bones" as He had), but as a *Man* with a body, though not in every particular the same as ours, yet in many points identical, and

certainly material, as He distinctly proved to Thomas. Whither then has He gone? to what material world or distant part of His dominions has He departed? Is it to some vast orb so far removed from our little dusky globe in the dark blue depths of space, that as we think of its distance, and endeavour to realize it to our imagination, we feel almost hopelessly separated from it, like mariners in a solitary ship in mid-ocean, or a boat's crew cast away on a desert island cut off from all companionship but its own? Or, on the other hand, have we reason to think that there is at the present hour, as there always has been, such a real connection both physically (*i.e.* astronomically) as well as morally and spiritually between the two worlds,—between this island-world called the earth and the distant mainland or continent of heaven, the home of God and His holy angels, as well as the “perfected just,”—that space alone divides us, physically and literally, while but the slender plank of death separates us from it individually; and that, as over that dark bridge each moment souls are spanning the gulf, they are admitted at once to its golden light and unfading glory? These are questions which, though science may throw some partial light upon them, Revelation alone can fully answer, and which it is admitted by all who believe the Bible are answered by that wonderful book in the affirmative; fully, though not perhaps as fully as our curiosity may desire; and satisfactorily, at least so far as it is necessary or possible for us with our present faculties to apprehend such a subject.

Among the sciences, astronomy, however, is the only one that can throw even a glimpse of light upon it other

than the Scriptures afford; and though its testimony is indirect and necessarily imperfect, yet it is of considerable value and interest as far as it goes, serving to impart a reality to the statements of Scripture, and thus assist in confirming its truth.

That there is, then, a physical or material connection between our planet and other worlds, though so distant as to be out of our sight altogether, is the first inductive step in the testimony which astronomy affords and suggests as to the inferential existence of a material heaven.

Astronomically viewed, we perceive at once the earth is no solitary island-world, no strange sail in the great sea of space, no mere isolated globe. Belonging herself to the sun, she is only one out of a number of a family resembling herself, that are warmed by the same vast hearth-fire, and, circulating round him, are likewise carried forward with him in his more gigantic, and as yet unmeasured, orbit.

But, our solar system, as it is termed, with its family of worlds, occupying as it does a circle of at least six thousand millions of miles in diameter, dwindles to a mere point in the universe of starry space; and, amidst the millions of bright suns, and clusters of suns, with their attendant worlds, that encompass and surround us here, we find ourselves to be but a microscopic unit, small as a grain of sand in the archipelago of similar bodies that belong to our own astral system, or nebula, as it is termed, bounded as it is thought by the Milky Way.

Vast, then, and inconceivable as are the distances from us, as from each other, of these innumerable suns

and systems that burn and roll around us here, and without leaving the boundary of our own star system, we can at once perceive the physical relation which our planet bears to every other member of the same system, about the centre of which, or nearly so, our sun has been placed by astronomers as its normal position.

Thus viewed, it may be affirmed, everything connected with our globe bears an astronomical relation to others under analogous conditions: its size, its place, its path in the heavens, its relative distance from its own primary or sun, as well as from other suns or planets,—its rate of travelling, as also other circumstances connected with the wondrous arrangements relating to it,—its diurnal or daily, as well as its orbital or annual, motion,—everything has been determined, designed, and adjusted with a view to others, and accordingly with a precision so admirable, and so plainly perceptible, that we know were any one of the conditions under which the earth, or any other planet or sun, exists, now absent or altered, chaos and confusion would ensue instead of the order and beauty maintained in the system, and catastrophes the most tremendous to contemplate would involve the universe of stars to which we belong in utter ruin.

But not only does astronomy thus inform us of our relative physical connection with the more immediate members of our solar system as a unit belonging to it, and even to the more distant suns that we see sparkling around us, and which are within reach of human sight, either unassisted or through the medium of the telescope; but also permits us to infer the mysterious connection of our world with a far more distant part of the universe, quite out of our sight in fact, and beyond even the reach

of the telescope. This great fact has been thus brought to light. It has been ascertained beyond question that the sun, as we have already remarked, is moving onwards in a supposed arc or orbit of vast dimensions, carrying necessarily also his satellite worlds with him on his journey; and the problem has been started for astronomical investigation, Whereabouts does the centre of this great circle lie?—*i.e.* in what direction are we to look for it? Given the arc or segment of a circle, and provided we have likewise its plane, a simple calculation will tell us where to look for the centre? As, however, little more than the *direction* towards which our sun or solar system is travelling can be approximated to, and the angle of motion or the curvature of the line in which it is travelling can be as yet little more than suggested (the orbit being so vast as to appear to us almost a straight line), while the plane of the supposed orbit is even still more difficult to ascertain, but little that is positive can as yet be affirmed about it. And the proposition of finding the exact direction in which to look for the centre of the sun's vast orbit is no easy task, and can scarcely be considered as yet fully accomplished. Different positions in the heavens have, however, been assigned for it, and pointed out by different astronomers as the probable position of the central sun or mass of matter round which our great orb and his companion worlds are circulating. Among the eminent astronomers who have undertaken the difficult problem, Mædler perhaps stands the first. He entered upon this calculation some fifteen years ago, with indefatigable energy and industry, and at length boldly pointed to the star Alcyone (the principal of the group of the Pleiades in

the constellation Taurus), as the probable actual central mass round which he moved. Mædler's theory, however, notwithstanding the credit which justly attaches to him for the magnificent conception implied in it, as well as the incalculable labour attending such a work, has not been altogether confirmed by other astronomers, some of whom assign a somewhat different direction of movement and plane, and consequently different direction wherein to look for the centre. But here it must be remembered that, after all, little more than the mere direction of the central mass could, with the imperfect data possessed, be pointed out. The vast length of radius or distance which lay between the sun and its centre could never be approximated without far more perfect data than we possess, or are likely ever to possess. The fixing, therefore, by Mædler, on one particular star as that distant central point or mass, has not been confirmed, notwithstanding other testimony seemingly corroborative of this theory which he has adduced from the "proper motion" of the other stars in the group to which Alcyone belongs. There is no limit, indeed, to what might be the length of that invisible radius or chord of gravity which binds our primary and his family of worlds to the distant centre round which he is travelling. Supposing the direction of that centre to be as Mædler has described, and to lie towards Alcyone; yet Alcyone, distant as it is from our sun, might be but the first step or round in the celestial ladder,—the first inch in the celestial mileage,—the first huge mile in the celestial millions or billions of such measurements, by which infinite space is portioned; while inconceivably beyond all may still lie the outskirts

or suburbs of the central mass of glory of the celestial city or world to which we are bound fast. What the power of gravity may be, or how far it may extend its influence in space, is only to be limited by its size and density; and measuring it according to the Newtonian law, and having infinity to deal with, there is no limit that we can assign to its distance any more than to its magnitude. If the magnitude and density of the body be sufficient, enough power of gravity may be put forth to hold not *our* solar system only in its grasp, but innumerable suns and systems. One thing is certain,—the magnitude of the centre which, while out of the sight of the human eye, even when armed with the most powerful telescope, still continues to hold our own sun and his family of worlds fast by its invisible chain, must be something vast, and inconceivable by us.

Thus then, though the precise direction and the distance of our sun from his invisible centre is still unknown, there is little doubt of the existence of such a centre. This granted, then the physical connection of the earth is established by the same argument that connects the planet with its primary: whatever distant point the sun may be attached to, the earth is likewise attached to that point; just as our satellite, the Moon, is doubly connected with the earth and Sun, so are we with the sun and the central mass to which he belongs.

One thing, then, appears evident here, which astronomy unfolds to us. We are not as a severed link in the great world of creation, we are not a mere isolated globe of matter floating, as a ship and her crew, hopelessly and helplessly in a boundless sea of space unconnected with other lands. We belong to, and are actually

attached, as by an iron chain, to some other world in a distant part of the universe, far beyond our own Sun, and which unglorified mortal eye has not yet seen; but the chain is *there* nevertheless, as well as the country it belongs to, and the existence of both are as much a matter of fact as the existence of America and the Atlantic cable, though both are alike invisible to us here. That wondrous wire connects the Old and the New World so as to enable the inhabitants of earth, though invisible to each other, to converse in words of lightning. The Newtonian chain of gravity in like manner connects the heavenly with the earthly: how far, notwithstanding the vast distance, a conversation and intercourse is possible to be carried on between the two countries, past experience has shown; how far, and in what manner it may be, and is still maintained, and how long it shall continue, are questions for further consideration. In the meantime something has been done by astronomy, if it has only suggested the magnificent and cheering thought, that we are not only connected relatively with the millions of suns and systems that we behold around us, but positively and physically with some vast centre out of sight, and to which all worlds and systems alike belong and render homage. What, if this should be the heaven of heavens, the very throne and habitation of God, the highest and best of all worlds, the present abode of the Man Christ Jesus; and round which, turning as on a mighty pivot, the universe of creation and its gigantic frame-work rolls its starry face successively towards its Creator! Is there anything irrational in such a supposition? On the contrary, are there not many reasons derived from other sources for thinking it

in the highest degree probable? It must be allowed, however, whatever may be thought of it, that astronomy, without positively asserting it, suggests here a grand and sublime idea. But here science bids us farewell: having conducted us thus in imagination, as it were, to the very portals of the unknown regions—the celestial city above,—she modestly retires; leaving us, however, not in the dark, but in the hands and under the guidance of another and “more sure and powerful” witness,—and that is, the inspired volume of the Scriptures. *That* assures us not only of the reality and certainty of the existence of such a place as heaven, though it tells not its celestial longitude or latitude, but of the actual *physical, moral, and intelligent connection* between the two worlds—heaven and earth; established, not by gravity, but by actual intercourse of the inhabitants,—by the communication which has subsisted between the two worlds, through the medium of intelligent Beings (who have visited us) of a race far superior to man, and who have passed and repassed from one world to the other, crossing the vast gulf of space that lies between with far more ease than we can now, with all the aids of science we possess, pass from one country or city on our own globe to another,—their flight resembling, indeed, in its speed more the flashing of the electric spark along the wire, that now sounds and spans the solitary depths of our Atlantic, than any mortal flight, but thus establishing beyond all question the intimate relation of this terrestrial ball and kingdom of earth with another and a grander and a brighter world and kingdom. But here we pass from the testimony of science to the domain of ancient and inspired history.

CHAPTER II.

SCRIPTURAL EVIDENCE.

"Alexander, dead is not, but lives above the stars."—*Inscription on a Christian Martyr's tomb in the catacombs of Rome, A.D. 163.*

"Far above all heavens."—EPHES. iv. 10.

WE will now inquire, What is the testimony which the Scriptures afford to this deeply interesting question? The proofs contained in the Bible are (as I take it) neither few nor slight, to the great fact suggested by science; so much so, indeed, that, valuable as the testimony of astronomy is as a confirmation of, or contribution to, inspired truth, yet, had the knowledge we have obtained of the universe done nothing in that direction, the great doctrine of heaven as a place or locality in the heavens would remain the same. Stereotyped as it is in the Book that records it, it has been equally stereotyped on the mind of every person that has read that book and believed in it. It could not indeed be discredited without discrediting the entire volume that reveals it, in which it is the central picture, next to Christ Himself; the great object towards which all our hopes and fears are directed; our final home, the reality of which is indelibly imprinted on our mind from our earliest years, as being also the home of God and the holy angels, and the "spirits of the just made perfect."

At a parent's knee we have been taught to look upward to the deep blue above as indicating the direction of the place where God lives; and unless the canker of infidelity has crept in to mar the lovely vision, it has remained on our mind to the last, as one of those bright cheering thoughts that lessen the cares, and banish (when we think of it) much of the gloom of approaching death, and the sorrows and anxieties of human life. But where has the idea been derived but from the inspired volume alone; for science could never assure us of it? To *it*, therefore, we may look as containing, though not *all* that we desire to know, yet something more definite and certain than astronomy can afford us, and which, with the aid that is afforded by that noble science, so far as it goes, all but demonstrates the great truth, that there *is* a central heaven, the special residence of the Most High, where His glory is manifested, which is the home of many a bright angel and archangel, and from which man, when made like unto the angels (*ισαγγελος*), if not equal to them, shall not be excluded. The evidence of Scripture on this subject is confined to a few points, but not the less clear on that account. First, there is the direct testimony to the existence of heaven, with a general and chiefly figurative description of its glory and its inhabitants. Second, the indirect testimony furnished by the actual intercourse that has subsisted between some of the inhabitants of heaven with the inhabitants of the earth, together with the deep sympathy which we are informed exists among those inhabitants of heaven for the human race on earth; crowned by the actual ascension from earth to heaven in the body by two of our race, and finally that of our

Lord Himself, not to speak of the subsequent experience of St. Paul of the same glorious place, entitled by him "the third heaven" and "paradise" (2 Cor. xii. 1—4). With respect to the first part of this scriptural evidence, it may be premised that the names which are assigned to it in Scripture are in themselves significant, so as to indicate, to a certain extent, what is to be expected. Thus, in the earliest record of it, which is to be found in 2 Chron. ii. 6, and vi. 18, it is termed "the heaven of heavens:" *i.e.*, the heaven above or among the heavens,—meaning by the latter the starry heavens; the word heaven itself indicating "a lifting up," from the Saxon "heave." In the same inspired prayer of Solomon it is called also the dwelling-place of God: "Hear Thou from heaven Thy dwelling-place" (2 Chron. vi. 21.) So, also, David terms it, in Psalm cxxiii., "Oh Thou that dwellest in the heavens."

Thus, in this and many other similar expressions, the idea that there is somewhere in the universe a place where God (as it were) resides, or where His presence and glory are specially manifested in the presence of the holy company that are admitted to dwell there, is plainly conveyed. To such a place, doubtless, Paul was caught up or conducted, either in the body or out of the body, to the "third heaven" or "paradise,"—by both which names he describes it, being synonymous with the "heaven of heavens." There he says he heard "unspeakable words," which it is not lawful for man to utter: *i.e.* the language of heaven spoken by its inhabitants; a language either that could not be spoken by man, or should not be revealed by him.

That there is such a place is plainly signified also in

Luke i. 19, where the angel Gabriel, announcing his message to Zacharias, says, "I am Gabriel, that stand in the presence of God; and am sent to speak unto thee." So the Evangelist relates in the same chapter, the same angel Gabriel was "sent from God" to the Virgin Mary. It is thus plainly implied and taught that there is a place in the heavens where God is present in a different sense from that in which He is said to be omnipresent: in other words, in heaven He is personally present; and to and fro from that place angels have passed and repassed to earth and back, when sent by God as His messengers to do His pleasure. To that same place it is declared by Luke our Lord Himself ascended (Luke xxiv. 51): "While He blessed, He was parted from them, and carried up to heaven;" an event described or prophesied previously by Himself to Mary, in words that declare it distinctly as the residence of His Father, as in John xx. 17: "Touch me not, for I am not yet ascended to my Father; but go and tell my brethren, I ascend unto my Father and your Father, to my God and your God."

Here His ascension is described in one place as to heaven, in the other to His Father; therefore to one and the same place, to His Father who He states in the Lord's Prayer is in heaven.

Its vast distance from the earth is also implied by Paul in Eph. iv. 10: "He that descended is the same also that ascended up far above all heavens," meaning probably above the first or aerial heavens, or possibly the starry heaven visible to us. Also in Heb. viii.: "We have such an High Priest, who is set on the right hand of the throne of the Majesty in the heavens."

And there He sits, as King of kings, and as our Advocate and Mediator; "for Christ is not entered into the holy places made with hands, which are the figures of the true" (then there *is* a true heaven of which the holiest of holies was to us but the figure); "but into heaven itself, now to appear in the presence of God for us." (Heb. ix. 24.) Here it will be remarked, the presence of God is again associated with heaven: it is plainly His dwelling-place. Again, John xiv. 2, 3: "In my Father's house," says Jesus, "are many mansions: if it were not so, I would have told you. I go to prepare a place for you. And if I go and prepare a place for you, I will come again, and receive you unto myself; that where I am, there ye may be also."

There are many points of deep interest in this short but important passage that deserve notice. (1) His Father has a house (*i.e.*, a dwelling-place). (2) There are many mansions in it (*i.e.*, abiding-places;—rooms, apartments, as it were, to the palace where God dwells). (3) This is a certainty, as true as Christianity: "If it were not so," says Jesus, "I would have told you." (4) It is a distant locality to which Christ must go, and from which He will return (a far country as He describes in it the parable),* further, it is *a place*,—not a mere *state* or *condition*. (5) It is a *prepared* place: *i.e.* prepared, and suited for, and made ready *now* for the people of God. (6) It is the place where Christ Himself will be and is: "I will take you to myself, that where I am there shall ye be also." The expression, "I am," here, does not indicate, as some have said, the place where He then

* Matt. xxi. 33.

was—the earth; but where He should be, wherever that was.

Thus the direct evidence of *a place in the heavens*, whither Christ went, where He ascended, where God dwells and is manifested specially in the person of Jesus Christ the second person of the Trinity, where also the redeemed people of God (once on earth) are, and the holy angels dwell and pay their homage to the King of kings, is plainly declared by the direct evidence not only of the passages of Scripture now quoted, but by many others, which are but a repetition of the same thing.*

But let us see if there is any glimpse given us of the same great fact by a representation of the scene itself, unfolding the very courts of heaven to our gaze, and conveying to our mind irresistably the impression that after all what the Prophets saw were not mere figures of the imagination, but pictures or representations of *reality*,—that is, of real heavenly things. When we come to think of it, indeed, it would seem the forms of Kingly Governments on earth are much more likely to be derived from the heavenly pattern, than the *heavenly* (as seen in prophetic visions) from the *earthly*,—as most commentators make them to be; it is far more probable that our forms of Kingly Governments and Courts are but miniature representations of the Government and Royalty and Administration exercised in the Courts above, where the King of kings reigns supreme; that in fact the very idea of kingly government was communi-

* 2 Chron. xviii. 18—22; Job i. 6, 7; Zech. iii. 1—4; Dan. vii. 9, 10, 13; Isa. vi. 1; Ezek. i. 1. 24—28.

cated originally from God to man, and that as man himself is made in God's image, so the petty kingdoms of earth, notwithstanding their imperfection, are really founded on the divine model; and what was called "the divine right of Kings,"—without being carried to the superstitious extreme that it formerly was,—is in fact, so far as the form of it goes, at least a Divine ordinance: indeed there is no question that this is the testimony of Scripture. "By Me," says God, "kings reign and princes decree justice" (Prov. viii. 16); and the powers that be, says Paul, are ordained of God; while David and the other Kings of Israel and Judah were termed "the Lord's anointed." It is not, therefore, unreasonable to think that the visions of scenes in heaven,—where God is represented, as it were, as holding His court for the administration of celestial matters, or terrestrial,—had more significance in them than we are in the habit of giving them, and should not be explained away as mere visionary illustrations of spiritual things, or *figures* of God's government illustrated by our own forms of government in condescension to our limited faculties,—but rather *similitudes*, or *resemblances*, or *patterns* of the reality, or what is actually occurring, or has occurred, in heaven.

Thus viewed, the representations which were revealed to the Prophets, or are described elsewhere in the Inspired Word, should many of them at least be taken for a general description or picture of *reality*. To give an example, there is a remarkable vision revealed to Micaiah (2 Chron. xviii. 19), in which the cause and effect perceptible in the death of Ahab in battle, and defeat of the allied armies of Judah and Israel, are

revealed in the clearest manner, as originating in a solemn Council held above the clouds of heaven. The preface in which this vision is announced is in itself significant, and stamps what follows as undeniable truth and a real occurrence in heaven. "*Hear the word of the Lord*," exclaims Micaiah. What follows, then, it is plain *is* the word of the Lord, and not of man, from first to last. The Prophet then proceeds: "I saw the Lord sitting on His throne, and all the host of heaven standing on His right hand and on His left. And the Lord said, Who shall entice Ahab King of Israel, that he may go up and fall at Ramoth-gilead? And one spake after this manner, and another after that manner. Then there came out a Spirit, and stood before the Lord, and said, I will entice him. And the Lord said, wherewith? And he said, I will go out, and be a lying Spirit in the mouth of all His prophets. And the Lord said, Thou shalt entice him, and also prevail: go out and do even so." Here the beautiful vision faded away from the Prophet's sight, but not from his remembrance, nor the conviction in his mind of its reality, when he adds: "Now therefore, behold, the Lord hath put a lying spirit into the mouth of thy prophets, and the Lord *hath spoken evil* against thee." Here was a plain announcement of the truth of what he had seen in vision, and the effect of which was shortly after brought to pass, in the death of Ahab in battle, the defeat of the allied armies by the Syrians, and the palpable proof thus afforded of the lying spirit of the other prophets, who we have no reason to believe were lying prophets in everything they said, nor that they predicted it from the pure motive of their own minds, but because (as revealed in the celestial

scene) they were moved by the Spirit that was *permitted* as well as *commanded* to deceive Ahab, that he might fall. Now what are we to think of this remarkable vision? Was it a representation of a real place,—a real occurrence; or a mere ingenious plan and invention of Micaiah,—an ingenious and poetical mode of introducing the charge of false prophesying against the other prophets? The result that followed proved the truth of the prophecy at all events. The train of events that immediately followed the scene in heaven proved that it was no illusion or deception of Micaiah. Then why consider, as many do, the *result* of the prophecy to be the only true part of it, and the accompaniment or introduction to it, in which the cause is revealed, only an eastern fable or poetic embellishment? Why should *part* of what Micaiah said he saw be deemed *false*, or at best a mere parable or glamour of the imagination, while the result alone is true?

I cannot but think it highly improbable that any such important vision brought to a prophet's mind would be permitted by God to convey a false impression of fact; yet if no such scene as is described was enacted above the clouds and stars of heaven to affect the fortunes or lives of the unconscious Kings and their armies, then half Micaiah's vision at least must be charged with falsehood or delusion, and there was no such place as he saw,—no such scene was enacted above,—and he might fairly be classed, *so far as this part of his story went*, with his companion false prophets. But who that believes the Scriptures to be inspired will venture to affirm this? and if any one did, the result of the prophecy would disprove it.

There remains nothing therefore (as I take it) but to believe the entire vision, together with its result; and that the scene revealed to the Prophet's sight (though not itself a reality) was the picture or representation of a *real place*, and a *real occurrence in heaven*,—one instance out of the many that take place there, and by which we are taught that all the events of earth are ordained by God in the Courts above. And even as the laws that regulate our earthly kingdoms *here* are ordained by the Sovereign, or the Government and Councils of the nation, and carried into effect through the Ministers and instruments of human power, so the King of kings uses sundry means to accomplish His purpose in heaven, and the Councils of heaven are carried into effect by men, as *His instruments only*, on earth; kings and princes and nations and kingdoms decreeing and enacting only what has been already determined in heaven. But it is not only in prophetic visions such scenes are described. A similar scene, resembling this very much, is unfolded as a simple *narrative* in the Book of Job,—a Book which is in itself a complete story,—and is related as a matter of fact. In Job i. 6, 7, it is related: "Now there was a day when the sons of God came to present themselves before the Lord, and Satan came also among them. And the Lord said unto Satan, Whence comest thou? Then Satan answered the Lord, and said, From going to and fro in the earth, and from walking up and down in it." Then follows the public challenge of Job's righteousness by the Almighty to Satan, in the presence of His angels and all the Court of heaven, assembled there by command on a certain day, together with Satan's reply (both of them, it may be said, equally

characteristic of the Author of all good, and the author or minister of evil). The permission obtained by the latter to persecute and try God's faithful servant (his person only excepted) then follows immediately, as effect follows cause; and a series of calamities are poured out like a hail-storm on the head of God's righteous and patient servant, beginning with the loss of his health and all his property which he had accumulated, and ending in the loss of his children, till he was left in a few hours without a child even to comfort him. But throughout the entire of this fiery ordeal we are told Job sinned not. He stood as firm as the rock over which the Atlantic wave breaks in thunder until it retires: his faith remained unshaken.

But a second time the strange scene in heaven is repeated. God and Satan again meet, again converse about Job, referring to what has taken place since. Satan though defeated is not silenced, nor convinced; and again permission is obtained to continue the trial on the blameless man: this time on his person, restrained only by Divine power from taking his life. Then follows the second series of calamities, as in the first instance, and Satan smites Job with sore boils from the sole of his foot unto his crown.

Now how wonderful is all this scene to our apprehension; yet it is a plain and intelligible narrative of fact. It is not clothed in any figurative language, such as the prophets used; it is not a parable either, nor have we any reason to believe it was so intended we should receive it: if it *is*, then the whole book of Job must be considered a parable, for without this introduction to the story it would be no story at all,—it would

be unintelligible; but there is not the slightest evidence to warrant such a belief. Our Lord's parables were invariably announced as being parables, which this is not; nor even if it were a parable would it destroy or injure the *reality of the description*. In our Lord's parables the story was always a *representation of reality* as well as a vehicle for spiritual instruction. The groundwork of His parables was derived from real and visible *things*, and *real circumstances* relating to this world,—things that happened and were actually enacted, and not visionary *enunciations*; so that even in this view of the matter, and were the book of Job parabolic from beginning to end, there would be no reason for not believing the groundwork of the story to be a representation of real things: but there is not a shadow of proof to lead us to think that it is anything else than a real story,—a genuine narrative or biography of the man called Job, from beginning to end,—and every circumstance narrated in it to be equally genuine, and a true representation of what occurred.

The *story* itself, too, is not highly coloured with the imaginative glow of Eastern inspired poetry. Whatever poetic beauty there is in it is to be found principally in the language of Job and his friends, which at times rises to a climax, and is expressed in an impressive eloquence and beauty of language that has never been equalled, proclaiming its divine origin; but the story itself, and especially the introductory portion of it, is unadorned with this, and is but a plain and unvarnished, simple narrative, with a most important moral attached to it, revealing to man a great mystery,—viz., the cause of a good man's afflictions (otherwise unknown), and tracing

them (doubtless in many other instances as well as in Job's case) to their real source, and teaching us the same great lesson Job learned,—patient submission to and unshaken faith in our Almighty Creator to preserve and protect us. But the point I would draw attention to is,—the narrative before us introduces us to a *wonderful place*, which is not described, save as the *place where God is*, and where He holds as it were His celestial Court, and at stated times or periods with the sons of God,—meaning thereby the holy angels and spirits that inhabit that place generally, though it would seem not constantly,—as men on earth do not constantly inhabit their own houses, but go abroad and travel, and return home again. Thus these spirits or angels are represented as being required to assemble in the presence of God, at stated times, to give an account of their doings in different parts of the universe constituting the dominions of the Most High, and embracing probably the different abodes of God's intelligent creatures, scattered in many a bright mansion through infinity. Such a mission, at least, Satan appears to have been on,—but *his* an evil one,—and doubtless by permission. We may remark, in passing, here is a curious description of the discipline of heaven; in some degree *still* a probationary state for its inhabitants, it would appear, whose conduct undergoes a periodical supervision by the Almighty, which it is presumed is necessary *even there*. Indeed the case of the fallen angels, including Satan himself, would seem to show its necessity. This may seem strange to us at first, but strange only from our ignorance, and a moment's reflection will show us that a state of probation is a natural state to all

creatures, that is to say, a state of *trial* as to *obedience* or *disobedience*, *loyalty* or *rebellion*, *trust* or *distrust*, is the natural position of every creature of God in their relation to Him. The successful and continued probation of the holy and the just in heaven will obviously constitute their highest happiness, their chiefest glory.

Were there no *trial* of their obedience, to intelligent creatures there would be no *effort* towards what was *good*, and no happiness, which is the result. *Why*, or *how*, an evil spirit like Satan is admitted to such a place we are not informed, no further than relates to the important part he is to play in the narrative about to be told. It is probable, however, his admission on this occasion was an exceptional case: but we know not. We do know, however, that the book of Job would be unintelligible without his admission in this instance, and we do learn also from what follows that he is a *spirit* of *great power* and *malice*,—not a mere influence, but a person; that he is the instrument in God's hand of much of the misery and affliction visible in this world, but that all that he can do is restrained and under the government and regulation of the Most High, who will not permit him to hurt a hair of the head of one of His people, or to injure them beyond that which He has commanded, and has intended for their ultimate good.

Here then is a glimpse or representation of heaven, and its inhabitants, the actors in it. The central figures, God and Satan, each occupying characteristically the very position assigned to them respectively in other parts of Scripture. Here we are distinctly taught there is a God, and there is a Satan. The place they are in,

too, is revealed; assembled crowds of angels line it, and surround the throne of God. Though man is not represented as being present, his *case* is remembered there, and the great mystery of human affliction is made known, in one particular at least, in a marvellously plain manner. The agency of God and Satan are revealed, and heaven and the things seen there are brought under our clearest observation and reflection.

There is another vision of the Prophet Zechariah which much resembles that of Micaiah, and where Satan is likewise introduced in the picture as he *should* be (characteristically) as the opponent of God and man. (Zechariah iii. 1—4.) So also in Daniel vii. 9: "I beheld till the thrones were cast down, and the Ancient of days did sit, whose garment was white as snow, and the hair of his head like the pure wool: his throne was like the fiery flame, and his wheels as burning fire. A fiery stream issued and came forth from before him: thousand thousands ministered unto him, and ten thousand times ten thousand stood before him."

Who can doubt this to be the representation of a grand and solemn reality yet to be enacted, but pictured to the mind of the Prophet in vision only. The visions of Isaiah and Ezekiel bring us to the same wonderful place where God is enthroned. Thus in Isaiah vi. 1: "In the year that king Uzziah died I saw also the Lord *sitting upon a throne*, high and lifted up, and His train filled the temple. Above it stood the seraphims (*i.e.* the angelic host). . . . And one cried unto another, and said, Holy, holy, holy, is the Lord of hosts: the whole earth is full of His glory." So likewise Ezekiel,

when he was captive in the land of Chebar, describes the wonderful vision of the wheels. When, he says, the heavens were opened, and he saw visions of God. In this remarkable vision, the Prophet labours to convey a notion of the glory of the place in language which, notwithstanding its poetic beauty, can but give us a feeble notion of it. Here the holy angels are represented as controlling and regulating the affairs of the earth, by the wheels of Providence showing the agency of these holy and intelligent beings. A sublime description is then given of their movements and speech (Ezek. i. 24.); of the *former* it is said, the living creatures *ran* and *returned*, as the appearance of a flash of lightning. "And when they went (says Ezekiel), I heard the noise of their wings, like the noise of great waters, as the voice of the Almighty, the voice of speech, as the noise of an host: when they stood, they let down their wings. And there was a voice from the firmament that was over their heads, when they stood, and had let down their wings." But then comes a description of the Almighty Himself, in language never excelled, and only to be equalled by St. John's,—a description which conveys to the mind as far as anything could the *Personality of the Deity* (doubtless the second person of the Trinity), as follows: "*And above the firmament* was the likeness of a *throne*, as the appearance of a sapphire stone: and upon the likeness of the throne was the likeness as the appearance of a *man above upon it*. And I saw as the colour of amber, as the appearance of fire round about within it, from the appearance of His loins even upward, and from the appearance of His loins even downward, I saw as it were the appearance of fire, and it had

brightness round about. As the appearance of the bow that is in the cloud in the day of rain, so was the appearance of the brightness round about. *This was the appearance of the likeness of the glory of the Lord.* And when I saw it, I fell upon my face, and I heard a voice of one that spake." Now what are we to conclude from all this magnificent description? Surely it is not merely poetic embellishment: it must have been intended to convey (however feebly) *some* idea of the glory of God's celestial habitation. Indeed the words of the Prophet himself are sufficient to assure us it is not a mere figurative scene that has no reality, for *this* (he says) *was the appearance of the likeness of the glory of the Lord.*

Passing now from the Old to the New Testament, let us see what St. John says of it in the Book of Revelation, and here we shall find frequent and abundant and somewhat minute descriptions of the celestial mansion, conveyed, it is acknowledged, in highly figurative language, but not the less important on that account, or failing to convey to the mind clearly the impression not only of the reality, but of the (to us mortals) ineffable and indescribable glory of the place. In the twenty-first and twenty-second chapters especially, we have a description of the heavenly Jerusalem,—"that city whose Maker and Builder is God; that building of God, that home eternal in the heavens,"—of which the literal Jerusalem was but a type or figure. It is thus described: John is carried away in the spirit and seated on a great and high mountain, from whence he beholds "that great city, having (as he says) the glory of God: and the light of which was as a stone most

precious, even like a jasper stone, clear as crystal" (this was the *general effect*, not unlike that of a bright star, such as Sirius, or a planet like Venus). He then proceeds to describe it most minutely: its foundations were garnished with all manner of precious stones. These stones if grouped together would resemble, indeed perhaps *exceed* the solar spectrum of our rainbow in beauty and colour. In this its glory resembles that which Ezekiel saw. The dimensions of this city were gigantic: its walls great and high, of jasper; its buildings, of the purest gold, pellucid,—*i.e.*, though gold, yet transparent like unto clear glass; an effect not possible to be produced here by man's art, nor seen in any substance with which we are acquainted, or manufactured by the art of man; its gates, which are twelve in number, answering to the twelve foundations corresponding, were composed of pearls, each gate a single pearl; the watchmen of these gates were angels; the streets of the city were like the walls and other buildings, composed of transparent gold. No temple is found there, for the *throne of God* and of the Lamb is in the midst of it, and constitutes its only temple; no night overcasts the sky there, no moon shines, no sun arises, for the Lord God Almighty was the temple of this divine residence, the Sun which shines with the splendour of everlasting day. Through the streets of this golden city gushes the river of the true waters of life, proceeding from the throne of God and of the Lamb. The imagination sinks and fails before such a description. *No one* can read it, indeed, without feeling the impression which it makes; even those who are ignorant of its real value and application, and insensible

to its importance, cannot but esteem or admire it for its poetic beauty, or as an allegory.

To the Christian, however, it has a deeper significance, and while acknowledging the description to be figurative, he feels it to be a portrait of what is real, and intended to intimate the existence of a place, the glory and beauty of which is so great as to surpass the power of ordinary language and description to convey a notion of, and therefore has compelled the writer (under the teaching of the Holy Ghost) to call in to his aid the most beautiful objects the eye of man could rest upon, the most lovely landscape the imagination could conceive, framed in and adorned by the most sublime and glowing language the ear ever listened to; and in the midst of this blaze of light and colour and brilliancy and poetic beauty, glory and immortality, to proclaim,—Here is the heaven of heavens!

But the testimony which Scripture affords to the existence of such a place in the heavens is further proved by the intercourse which has subsisted from time immemorial between the inhabitants of heaven and those of the earth; the former having visited the earth,—come, indeed, from the very courts of heaven itself, resplendent with its brightness, reeking, as it were, with celestial glory,—come as ministering spirits to man, and in like manner departing again to their native home on high.

There are few questions perhaps of deeper interest than this subject presents to the mind of the thoughtful inquirer.

If a native of some distant and unknown part of our globe appears in our civilized regions, it naturally

excites much interest and curiosity: it assures us, first, that there is a portion of our little world that we have never seen, and yet that surely exists;—the very truth that men are most likely to question, as did the crew of Columbus, although assured of its certainty by his superior intelligence and foresight. The native of a strange country assures us of the existence of that country; his strange speech, his dress, his appearance, his voice, his manner and habits,—all bring conviction to the mind beyond the possibility of doubt; and if, besides, he is enabled to describe the part of the globe he comes from, the nature of the country, and the people who are his fellow-countrymen,—who can doubt the fact? Now transfer this to the angels of God: once ascertain the fact of their having appeared on earth, having spoken and acted and declared distinctly where they came from; that they belonged, not to this small planet, but had, as it were, dropped from the sky above us, flashed from the heavens upon us, left “the heaven of heavens,” and the throne and presence of God!—and who shall be bold enough to question or deny it? The certainty of the fact is established by the arrival or departure of the strange visitors. The intercourse between the two countries, heaven and earth, is then proved, and becomes as palpable a fact as the intercourse of nations here proves that there is another country besides our own; a bridge is at once thus thrown across the supposed impassable gulf of space, and the barrier that has seemed to separate the planet we inhabit for ever from all other residences in the universe, is at once removed; and though to man in his present condition it seems as though his home has been

specially contrived, so that he shall never leave his present abode or associate with other Beings, the arrival of a single intelligent Being from another country in the heavens at once dissipates the illusion, breaks the charm, and shows not only the possibility and certainty of transit between the two worlds, but also the certainty that there is a heaven where angels dwell, as surely as there is an earth where man dwells. And when we come to examine the records we have of the appearance of such creatures in our world, we find that their visits have been—not, as erroneously described by the poet, “few and far between,” but quite the reverse; and that the Scriptures assume throughout a constant intercourse maintained and deep sympathy felt for man by this noble class of beings—the true nobility of heaven,—superior to ourselves in intellect and power and virtue, as doubtless they are in numbers.

That there are such beings, and that they form a most important portion of the creatures of God, the Scriptures so distinctly inform us, that if we reject belief in their existence we must reject likewise our belief in the entire of the Old and New Testaments, as both bear their testimony generally to the fact, in language that cannot be disputed; while in the history of man's redemption they form so important a feature, and play so important a part, that if their existence is ignored or denied, the whole framework of Christianity will fall to pieces, and the most important testimony to its truth will be lost.

That the heaven of heavens is the abode or habitation of these glorious creatures we are specially informed. That delightful world is the place towards which all our

own hopes and expectations are directed, the home to which we are invited to look as our final rest from every trouble, and the seat of all the enjoyment we are capable of attaining. With the inhabitants of that blest world we are told we shall, if we are wise, be one day acquainted and intimately united, and shall live in the midst of them for ever. Of this world, therefore, and of those who dwell there, we need information, and accordingly it has not been withheld from us.*

But there is one more consideration of interest to us in this matter in the sympathy thus established and maintained between the inhabitants of the two countries. That sympathy does exist we are assured by the Lord Jesus Himself, when he says (Luke xv.), “There is joy among the angels of God”—in the presence of God—“over one sinner that repenteth.” What does this imply, if it does not assure us of the deep interest which the inhabitants of heaven feel in the affairs of mankind?

The Apostle Peter indeed tells us that “the angels desire to look into these things” (1 Pet. i. 12), meaning the matters relating to the redemption of man; while the Apostle Paul declares that it was God's intention and “eternal purpose” that they should be informed of it. “That to the principalities and powers in heavenly places might be known by the Church the manifold wisdom of God according to the eternal purpose which He purposed in Christ Jesus our Lord.” (Eph. iii. 10, 11.)

Thus we are apprised of the interesting fact, that the

* Vide Rev. xxi. xxii.

matters of earth and relating to mankind are not only known above, but are the subject of the deepest interest to the inhabitants of heaven. Nay, more; that the inhabitants of both places are considered as constituting one family in Christ, of whom, says the same apostle (Eph. iii. 15), "the whole family in heaven and earth are named." Thus there is a moral chain, as well as a physical and literal one, that binds us to the bright land above us, out of sight though it be—at least out of our sight,—but not out of the memory or removed from the sympathy of millions of the noblest of God's creatures, who make our joy their joy, and doubtless our sorrow or sin the occasion of their deep sympathy.

In the string of beautiful parables in Luke xv., the Lord Jesus is represented as calling His friends and neighbours around Him, to rejoice with Him in the recovery of the lost sheep and the lost money. And who are these friends and neighbours, if they are not the heavenly host? And what is a friend, and what is a neighbour? *Who* are friends and neighbours to *us*, but those whose position enables them to know our circumstances and character, and whose friendship induces them to sympathize with us?

Thus England has great commercial and friendly relations with most of the civilised nations of the globe; and to all alike she is ready to extend the hand of friendship and sympathy; and though individually there are millions who have no opportunity of visiting those countries, yet there is no difference in the general feeling of the nation towards those who require or demand their sympathy or friendship, it is well understood and taken for granted, and forms a ground of

union, and confidence, which regulates the most important of our commercial relations, and makes England the greatest and most prosperous of kingdoms.

So there is a like confidence and understanding between the hosts of heaven and the inhabitants of this distant little planet; and though we cannot see nor talk with them as some of our race have done, a communication is established between the two worlds and their inhabitants; not by prayer to *them* which they are too loyal to accept (Rev. xxii. 8, 9), but through *their* and *our* divine Lord and Head, to whom alone our prayers should be addressed, and who doubtless (as in the parables already referred to) calls his angelic family around Him to make them participators in His joy and the joy of our salvation.

Here, when we would converse or sympathize with a distant nation, such as our American brethren, we flash our wants, our wishes, our thanks alike along the mysterious wire that connects us in speech with each other, and address ourselves to him who is the representative of the country, or the governing power by whom they are ruled.

The telegraph has thus done more to unite the nations of the earth in brotherly union and amity than any other discovery that science has ever made, and by its means, though so distant from us, we can now truly call the Americans our neighbours as well as our friends. Distance is annihilated when men can converse. But there is a more distant country than America, and a far vaster population, to whose Divine Head and representative we too may, with as great ease, send our telegraph of prayer, and supplication, and

praise, and thanksgiving. We have this promise distinct and clear, that while we are yet speaking He will hear, and before we call He will answer. (Isa. lxv. 24.) Any message of importance, therefore, that reaches heaven will be thus known and appreciated by the glorious company above,—our heavenly friends and neighbours. The earth is possibly viewed by them as one would look at the dark hull of some convict ship belonging to the sovereign, and containing a band of criminals and traitors, or, as it has been truly described by Chalmers, a rebellious province in God's dominions; yet from that dark vessel, from that rebellious band arrives every day, and hour, and moment some soul rejoicing in its deliverance from bondage and misery; and each sinner, as he plants his foot on the pearly shore of that blessed place, will be welcomed in such a fashion as the heavenly host alone can welcome him. They will conduct him to their Mount Zion—to their Lord—to the city of the living God—the heavenly Jerusalem, to an innumerable company like themselves,—the home of the elect, the throne of the Lamb,—the heaven of heavens.

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